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SECURITY-ORIENTED DEVELOPMENT OF INNOVATIVE-INVESTMENT MANUFACTURE

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Authors:
V. I. Zakharchenko [DSc[Econ.], Prof.] – introduction, chapter 1, conclusions;
S. V. Filyppova [DSc[Econ.], Prof.] – chapter 2;
M. M. Merkulov [DSc[Econ.], Prof.] – chapter 4;
L. V. Shyriaieva [DSc[Econ.], Prof.] – chapter 5;
D. O. Melnychenko [Graduate student] – chapter 3

Reviewers:
Derkach T. V., Doctor of Economics, Professor, International Humanitarian University;
Kovalenko O. M., Doctor of Economics, Odesa National Polytechnic University;
Logutova T. G., Doctor of Economics, Pryazovsky State Technical University

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The methodological approaches to a evaluating of a status of secure orienteering development of innovative-investment manufacture in industry based on the elements of the system of monitoring of its parameters directed on warning degradation of a main potential of scientific-technological development and economic growth issue from modern tendencies of Ukrainian economy development are considered.

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Автори:
В. І. Захарченко, д.е.н., проф. – вступ, п. 1, підсумок;
С. В. Філіппова, д.е.н., проф. – п. 2;
М. М. Меркулов, д.е.н., проф. – п. 4;
Л. В. Ширяєва, д.е.н., проф. – п. 5;
Д. О. Мельниченко, аспірант – п. 3

Рецензенти:
Деркач Т. В., д.е.н., професор Міжнародного гуманітарного університету;
Коваленко О. М., д.е.н., професор Одеського національного політехнічного університету;
Логутова Т. Г., д.е.н., професор Приазовського державного технічного університету

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Розглядаються методологічні підходи до оцінки безпекоорієнтованого розвитку інноваційно-інвестиційного виробництва у промисловості на основі елементів системи моніторингу його параметрів, які спрямовані на передбачення деградації основного потенціалу науково-технологічного розвитку і економічного росту, виходячи з сучасних тенденцій розвитку економіки України.

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CONTENT

ЗМІСТ

INTRODUCTION

Innovative-investment manufacture (IIM), possessing advanced technologies and innovative-investment receptivity, is able and called under certain conditions to play a strategic role in ensuring the new quality and pace of development of Ukraine's economy, thus creating security-oriented development (SD) and counteracting external and internal threats. This role is determined by the crucial contribution of scientific and technological, production and human resources of IIM in industry in the economic and military power of the country, their ability to provide leadership advantage in the face of competitive technological achievements of other countries as a guarantee against unpredictable developments.

Such productions, which are aimed at meeting new social needs in products, increasingly high scientific and technological level and with better consumer properties, simultaneously focus on the use of advanced technologies, resulting in comprehensive development of product and process innovations and achieve their multiplier effect on scientific and technological development.

The main features of IIM are:

– in the presence of a strong innovation-active potential, including scientific and technological (including basic research and development), design and technological units, scientific experimental and research and production base, as well as teams of highly qualified scientific and engineering workers to create new types of products and technologies;

– in a complex system of end-to-end financing from various sources of research, development and production for the full life cycle of knowledge-intensive products, taking into account multilevel cooperation; long duration of the innovative production cycle (up to several years); related problems of product payback, replenishment of working capital and loan repayment in conditions of high uncertainty and riskiness of R&D results;

– in high cost in relation to national resources of many new researches and developments which demand active participation of the state in creation of scientific schools and departments, in support of available scientific and technological, industrial and personnel potentials, in elimination of technological lag, etc.

These specific features in the functioning and economic and organizational condition of IIM distinguish them from a number of sectors of the economy when considering the methodological and methodological aspects of assessing their own SD and the impact of their activities on the SD of the country as a whole.

The loss of achievements of Ukrainian science, technology and industry will inevitably affect the international status of Ukraine as a significant state, its role in geopolitics, and the restoration of the lost will be either impossible in the foreseeable future or will cost incomparably more than its preservation.

Today, Ukraine is showing a deeper decline than the world economy, it will be approximately 6 % in 2020 (this is the point of view of the Ministry of Economy of Ukraine (www.ukurier.gov.ua from 12.08.2020). The nature of the recovery of the national economy will depend on the quarantine measures. The budget deficit is expected to grow to 5.6 %. The biggest drop in investment may be up to 20.3 %. However, already in 2021 there may be economic growth at 3.2 %, which does not compensate for the fall in 2020. Inflation will accelerate to 6.0 %. But there are always hopes for positive dynamics. The largest growth will again be expected in investment – 8.5 %. Unemployment will gradually decline to 9.2 %, but will not reach the level of a pandemic.

In the previous to the 1990s, the pre-crisis period, due to the consistent scientific and industrial policy of the state aimed at achieving a high level of development of science and technology, as well as scientific and technological independence and autonomy, in the structure of Ukraine's economy was created quite separate and efficient. , from the point of view of solving the tasks set before it, a complex of knowledge-intensive industries (mainly mechanical engineering), which are based on interaction with the developed raw materials, processing and energy base. In his person, the country had a significant and self-sufficient development potential, which provides growing internal and external needs in many types of complex products (aerospace, rocket and space technology, power and metallurgical equipment, ships, precision machines, devices, weapons, various materials, etc.).

Priority resource provision (primarily state funding of government orders) allowed to train and concentrate in these areas the most qualified scientific and production personnel, to create unique scientific schools and design teams, to develop and implement advanced technologies and materials, to equip production and research facilities. and foreign equipment, to develop a privileged social security system.

The potential of advanced industries was concentrated mainly in military-oriented industries and its main purpose was to ensure a guaranteed defense of the country from all hypothetical threats. The management system, the entire production infrastructure of the defense-industrial complex were created with the expectation of their reliable operation in the extreme conditions of the mobilization economy.

The scale of R&D and production was planned to ensure the maximum load of the scientific experimental base and production capacity (which deliberately exceeds the requirements of defense adequacy). Under these conditions, cheap labor and resources allowed to minimize unit costs and achieve an unattainable for other economies ratio “efficiency – cost”.

However, as confirmed by the objective reality, the predominant concentration of the highest technologies in the defense industry proved to be completely hopeless and unjustified (the difficulties of its reform and restructuring are now obvious) neither in terms of rational economy nor in world experience, because the level of development, stability and efficiency of the diversified Industrial Economy are determined primarily by the level of development of the industrial base as a whole, and not individual, even quite advanced, its fragments.

The process of reproduction of knowledge, developments and practical experience acquired in defense areas at the cost of concentrating the best intellectual, labor and material resources of the state for the implementation of targeted scientific and technical projects, in terms of policy management did not have a motivational economic mechanism economy and the displacement of obsolete inefficient technologies.

Current trends and development of innovation and investment potential in economically and industrially developed countries are such that the defense industry is improved and modernized mainly through innovations that move from the civil sector to industry, where demand and competition in consumer goods and services, as well as their much smaller (many times) life cycle in comparison with armaments and military equipment, better stimulate progress in scientific and technological development. An example of the continuity and rapid growth of the technological level of products of the widest application and demand is the development of microchips, the productivity of which doubles every year and a half, and the price is halved. At the same time, legal methods of competitive intelligence play an important role today [6].

It is mass civilian production and services, especially information, in a market economy are provided with the necessary financial resources to create scientific and technical developments and spread the bulk of innovations in other areas of the economy, including defense production, and not vice versa, although belittle the innovative potential of the latter is possible. In the United States, for example, in 1997, total R&D spending reached $ 205.7 billion (2.6 % of GDP), with civilian R&D completely dominating, accounting for 2.2 % of GDP.

Concentration of modernization potential of high technologies mainly within the defense-industrial complex of Ukraine reduced the efficiency of the economy as a whole, as it led to increasing disparities in its technological structure, limited the base and slowed the pace of overall technological renewal and economic growth.

The over-militarization of the economy (in Western countries, military spending in the late 1980s did not exceed 7–8 % of GDP, we reached 13 % of GDP) was reflected in all that increased resource consumption – the more intensively worked the defense industry, the more it needs natural and raw material resources, especially since it had to be exported as a source of funds for its modernization, as well as to replenish the accumulation fund in the raw materials industries and to fill the domestic consumer market with goods.

The last of these consequences of structural disparity had its cause – it is a significant fact that the bloc confrontation and the global struggle for spheres of influence contributed to the prosperity of “gift” exports of defense products, compared to the current state budget of Ukraine. The wages paid for these products, which are not provided with a commodity equivalent in the domestic market, created an increase in the inflationary “canopy” that should have failed every year. This happened at the turn of the 1990s, did not save from the catastrophe and measures were taken to “restructure” the economy with its poorly structured goals and methods of implementation.

The primacy of such wasteful and irrational resource consumption in peacetime, which indicates the short-sightedness of the political and economic strategy of the state, although it was possible, but, importantly, limited and short in terms of historical development.

The time constraint stems from the inevitable fact that the consistent implementation of this strategy poses fundamental threats to the foundations of national security, including economic security, some of which have already been implemented and others continue to accumulate critical mass during the economic crisis. This primarily applies to the high-tech sector of domestic engineering.

The fact is that as a result of a sharp decline in military spending (during the years of independence of Ukraine and before the military aggression in 2014) significantly more of the defense industry was unclaimed within the country (only part of production continues to be “afloat” due to export orders) and will never be in demand.

Having found itself without an order for investment in the conversion and re-profiling of its major industries, which became redundant, the defense industry began to degrade rapidly. The severity of the degradation has been exacerbated by the economic downturn (the country’s GDP has almost halved since 1990) and the financial crisis as a result of the shock therapy policy, the 2008–2010 crisis and the current ones caused by the SARS-Cov-2 coronavirus.

Industries that make up the defense industry as the most organized and dynamic structures, integrated with the whole economy, are more sensitive to its general state and development trends, as the latter generate market activity of their products and services, act on intersectoral and interregional ties (strengthen or destroy them), determine the investment climate in the country.

The strongest induction of crisis manifestations occurs in organizational and economic structures with long chains in multilevel and multisectoral cooperation of developments, as well as production of complex products, as cooperative relations increase sharply as the level of their interdependence on various factors, and, consequently, multiplicative effect of recession, as well as the degree of openness of such structures to external influences [1, p. 8].

In this regard, there is a two-pronged problem of SD assessment, which is manifested, on the one hand, in the assessment of SD most science-intensive industries, in the timely detection of factors aimed at destroying their potential, in developing a system for monitoring the manifestation and impact of these factors. Prevention and counteraction, and, on the other hand, in the assessment of SD threats in those areas where the products of knowledge-intensive industries are used and where the negative consequences of the curtailment of their activities are manifested.

This work is devoted to the consideration of the methodological bases of SD IIM evaluation, research of the general tendencies of their development and conditions for increase of efficiency. It was performed as part of research conducted at Odessa National Polytechnic University on the topic: “Competition secret service as a guide security management by innovative-investment development of enterprises of strategic importance for a national economy and safety of the state” (№ 0119U002005) for support of the Ministry of Education and Science of Ukraine.

1. INNOVATIVE-INVESTMENT MANUFACTURE AND SECURITY-ORIENTED DEVELOPMENT OF UKRAINE

In a modern, dynamically changing economy, scientific and technological development forms the international status of the country and the foundations of its national security. Progressive changes in scientific and technological development are mainly determined by the rate of creation and dissemination of innovations and the building up of the potential of complex IIM, which, being the most integrated into the general structure of the economy, are the main driving force behind its growth due to intensive and resource-saving factors [23].

IIM, located in almost all regions of Ukraine, are linked by multi-level scientific and industrial cooperation and a single economic space, which objectively works to strengthen the integrity of the country. Thus, the crisis in the knowledge-intensive sector of the economy has a destructive paralyzing effect not only on other sectors (the means of all types of transport, technological equipment in mechanical engineering, energy, metallurgy, the chemical complex, information infrastructure, where already now, for example, part of the territory Ukraine is not included in the zone of guaranteed round-the-clock reception of television broadcasting, communication and navigation signals, the implementation of various types of comprehensive monitoring of the Earth's surface, etc. due to the exhaustion of the technological resource of space information systems), but also creates threats to the social stability of society, economic and national security of the country in the whole.

SD problems, important in any country concerned about its independent status, have become especially acute and urgent in Ukraine in connection with external military aggression, a protracted and deep crisis that has engulfed its entire political, ideological and socio-economic system. The inertial manifestations of this crisis will have a negative impact on the potential of scientific and technological development of Ukraine, not only in the short term, but also in the very distant future. A particular danger for the carriers of this potential lies in the intangibility, latency of the damage caused to scientific and technological development at the present time and the severity of its inertial consequences in the future (in 5–15 years): at first glance, it seems that no significant damage to scientific and technological developments as a result of there is no suspension of funding for new research and development. In fact, each year of stagnation in the creation of this groundwork throws researchers back several years, allowing competitors to go into a formidable gap. An example from the history of Russian cybernetics has long become a classic.

Geyets V., considering the ways of modernizing the Ukrainian economy, focuses on the liberal-democratic foundations: “Liberal principles as the beginning of the free development of the individual must necessarily be realized in a society following a democratic path of development. But their implementation in technological, economic, social, political, psychological, mental and other realities of modern society can give different results, including those that contradict liberal principles, which happened, for example, in Ukraine” [2, p. 20].

It should be noted that the study of threats, indicators and conditions for ensuring SD of business entities as the most important factor in the strategic planning of their development 20 years ago by experts in the theory and practice of forecasting and planning did not even stand out as a topical issue (sometimes, in a purely ideological aspect, it was said about ensuring economic independence country for which all necessary measures have been taken). And only the rapidly and acutely manifested destructive tendencies of the past development of the totalitarian economy and the catastrophic results of the 2000s. the economic course were forced to pay most decisive attention to this suddenly arisen problem.

The situation with the provision of SD was recognized as close to critical, which required the development of an appropriate strategy for the economic behavior of the state [17], aimed at ensuring acceptable conditions for life and personal development, stability of society and preserving the integrity of the state, resisting the influence of internal and external threats that contribute to the collapse of the economy.

Much attention has begun to be paid to these problems not only at the national level, but also at the regional and sectoral levels, which is confirmed by a significant number of government documents, scientific research and publications [4; 5; 8–11; 16]. In them, the concept and assessment of SD are considered at all levels of the hierarchy of the organizational and economic structure: national (in relation to the economy of the state as a whole), regional, sectoral, corporate, level of an individual enterprise (economic entity).

S. Trofimov, who was responsible for regional policy in the Office of the President of Ukraine, emphasizes the available opportunities in a crisis: “Everything will be focused on the establishment of its own production within the country, which replaces import, so that we develop healthy competition between small and medium-sized businesses, so that everything is concentrated inside the country. This, I think, is a global trend and a very good reason. It is difficult, but circumstances dictate to pay attention to this, namely to the development of business, economy and other synergies, where the state plays a slightly different role – in the good sense of a conductor, an institution that directs, connects and develops it” (bulvar@mega-press.kiev.ua , June, 2020).

State strategy SD, formulating goals and indicating the objects of the strategy, includes: characterization of external and internal threats to the SD of the country; identification and monitoring of factors that strengthen or destroy the stability of its socio-economic situation in the short and medium term (three to five years); determination of criteria and parameters (threshold values) of indicators characterizing national interests in the field of economics and meeting the requirements of SD; development of economic policy, including measures of institutional transformations, mechanisms for taking into account factors affecting SD; directions of the state’s activities to implement the strategy.

Unfortunately, in the Program of the Cabinet of Ministers (2019, Prime Minister – O. Honcharuk), in the first in the years of independence of Ukraine, there was no place for events on innovative and scientific and technological activities.

For IIM, the SD assessment is important, first of all, because their actively used potential is a determining stabilizing factor in anti-crisis development, a guarantor of economic growth and maintaining the country's economic independence and security. Its loss is associated with hard-to-predict consequences of the de-industrialization of a unitary state, in which a diversified highly integrated industry (as opposed to the regional isolation of resource and raw materials industries and tendencies of disunity, thus, a single economic space) is one of the most powerful means of strengthening its unity.

Despite the fact that, in general terms, the complex of SD assessment problems has been formulated and investigated quite fully in many works, detailed working methods that take into account the industry specificity of production at the regional, corporate, micro levels, where they are most needed, are still emerging [1; 6; 12; 16], since only standard approaches are acceptable here, and the generalization of the system of criteria, indicators of SD assessment, as a rule, is inapplicable..

In this regard, one of the defining requirements for strategic planning of IIM at the modern, crisis stage of development is not only the need for a feasibility study of the efficiency of resource management (in conditions of excess production capacity, this complex criterion ceases to be self-sufficient and the main one), but also the provision of criteria and SD parameters, determination of measures to preserve the created potential, first of all, the search for additional sources of resource (financial) support, as well as ways to compete and gain strong positions in various segments of the domestic and foreign markets for high technology products.

2. THE ESSENCE AND THREATS TO SAFELY SECURITY-ORIENTED DEVELOPMENT

National economic security, according to the definition given in Ukrainian legislation [7], means the state of the economy that ensures a sufficient level of social, political and defense existence and progressive development of Ukraine, invulnerability and independence of its economic interests in relation to possible external and internal threats and influences.

The SD threat can be defined in its final form as a kind of damage, the integral indicator of which characterizes the degree of decline in the country's economic potential over a certain period of time. Under the threat we mean a set of conditions, processes, factors that impede the implementation of national economic interests or create a threat to them and business entities [11].

The state strategy in the field of ensuring SD of Ukraine identified external and internal threats, as well as a set of factors contributing to them (Table 1).

The reasons for the threats to the officially adopted SD strategy are largely due not only to past development, but also to the mistakes of the economic course carried out over the years of reforms, the amorphousness of the current scientific and technological policy, and the loss of economic control. These include the following:

1) the lack of scientifically grounded with preplanned research concepts, strategies and programs of socio-economic development with realistically achievable goals;

2) permanent lag in development, unsystematic and imperfect legal framework for the regulation of the economy;

3) high-risk monetary policy of the government in the banking sector, stock and foreign exchange markets, ineffective tax system;

4) fetishization of financial technologies in the process of transformation of the economy, which entailed their separation from its real sector, the replacement of real money by their surrogates or barriers, which actually redistribute the national income from the producer mainly in favor of the speculative financial market;

Table 1 – Threats and factors for SD

SD Threats	Threat factors
Ineffective, deformed structure	– resource and raw materials orientation of the economy, a high level of its monopolization, – low competitiveness of most types of products, – degradation of production, scientific and technical, personnel potential, – decline in production and loss of domestic and foreign markets for high technology products, – weak security of domestic producers, – a sharp strengthening of the positions of foreign manufacturers in the domestic market, – high external and internal debt
Increasing property differentiation of the population	– stratification of society, an increase in the share of the poor, – rise in unemployment, – non-payment of wages, – stopping businesses
The growing unevenness of the socio-economic development of regions	– objectively existing differences in the level of development of regions, the presence of depressed, economically backward regions, – violation of production and technological ties between enterprises, – an increase in the gap in the level of production of national income per capita between the subjects of Ukraine
Criminalization of society and economy	– rise in crime, – penetration of criminals into power and their splicing, – weakening of the system of state control in the domestic financial market, in the field of privatization, trade, export-import operations

5) growth of inflation and the absence of a normal investment climate in the real sector of the economy, preference for current expenditures over capital;

6) ineffective and unfair privatization of state property, public property;

7) creating conditions conducive to the appropriation and export of financial resources abroad;

8) loss of state control of natural monopolies, weakening of the regulatory role of the state in their pricing policy;

9) dishonest actions of many economic entities in the markets of Ukraine, their low legal discipline, lack or complete absence of economic ethics at all levels of management;

10) strengthening of regional and national separatism;

11) weak integration into the world economy (inconsistency of the scientific and technical level of most types of industrial products with advanced foreign models, a low share of foreign subsidies in national wealth);

12) discrimination (and, in fact, an economic war) by a number of countries of the international community in trade with Ukraine and in its striving for world markets.

Danylyshyn B. states: "... even partial implementation of inadaptive and inadequate program provisions for real production and economic processes affects the foundations of ensuring not only the economic security of the state, but also the scientific one as a whole" [5, p. 40].

The forms of manifestation of threats to economic security at different levels of the hierarchy of organizational and economic structures are somewhat different, despite the common action of destabilizing factors in a single economic space. These global factors include military conflicts, pandemics of infections, a general decline in production, a breakdown in the financial system, an increase in social tension, criminalization of society and the economy, further weakening of competitiveness, etc.

Therefore, it is incorrect to characterize a universal set of SD indicators for the potential of an economic entity at various levels of the hierarchy of structures such as "industry", "corporation", "enterprise". This requires more detailed assessments and more accurate instruments, and the very concept of SD of such an economic entity should be formulated taking into account the specific features of its functioning. Further, under an economic entity or science-intensive production we mean a separate enterprise, business group, corporation or their totality – an industry (if it does not have an independent organizational and economic design) that carry out scientific and production activities for the development and manufacture of complex science-intensive products, possessing and developing adequate science-intensive technologies for this.

In this work, SD IIM (business entity) means the protection of its scientific and technological, production and personnel potential from direct or indirect economic threats, for example, those associated with ineffective scientific and technological policy of the state or the formation of an unfavorable external environment, and the ability to reproduce it.

Of all possible types of SD IIM threats – catastrophic (natural and man-made), informational, competitive, criminal, associated with the incompetence of the owner in financial and institutional matters, organizational and a number of others – we consider only those that are directly aimed at destroying or weakening this potential under the influence of exogenous factors determined by the shortcomings or weaknesses of the state's scientific and technological policy in the real sector of the economy.

Other SD threats listed above, including ineffective research, production and marketing strategies, incompetent management, which also have an undeniable impact on the potential of IIM, are not considered by us due to their intrasystem origin. If the scientific and technological policy is such that the economic conditions inevitably lead production to a state of bankruptcy, force it to go into the "shadow" sector of the economy, use barter settlement technologies in the finished product market instead of natural monetary relations, deprive it of working capital, funds, not only for expanded, but also for simple reproduction, that is, knowingly "driving" production into a dangerous zone of increased economic risk, assessing SD by other, also essential safety components (information, criminal, environmental, etc.) has no practical meaning. In our opinion, it is more important to study the factors influencing the creation of such an external economic environment that favors positive trends in the development of potential production capabilities and meets its interests.

The state and development trends that provide SD of production exclude or minimize damage not only to the potential of this individual production, but also to the economy as a whole. This is the main function of providing SD. But at the same time, B. Danylyshyn notes that today "... the implementation of economic policy in the state is not an argument for the continuation and improvement of the processes of effective creation of the state ..." [5, p. 41].

Obviously, SD IIM has a direct causal relationship with the system and the results of strategic planning of its development, depending on the goals of production, means and possibilities of achieving them, the competitive environment, scientific and technological, financial and monetary policy of the state [21, p. 840].

3. GENERAL CHARACTERISTIC OF THE STATE AND TRENDS OF DEVELOPMENT OF INNOVATIVE-INVESTMENT MANUFACTURE

The indicator of "science intensity" of products of economic sectors "is determined by the ratio of the costs of all R&D ($V_{R\&D}$) carried out by any industry (including the acquisition of patents for discoveries, inventions, new technologies, etc.), to the total costs of production of this Industry (V_{pr}):

$$(V_{R\&D} / V_{pr})*100\,\% \,. \qquad (1)$$

Accordingly, those branches of production in which the indicator of "science intensity" exceeds the average for the manufacturing industry by 1,2–1,5 times.

The main characteristic features of IIM are:

1) the possibility and ability of obtaining, mastering, using and developing the results of the scientific and technological process, and the creation of new scientific and technological groundwork;

2) high absolute and relative costs for fundamental and exploratory research, R&D in the overall cost structure;

3) their complex nature, allowing to solve all the problems of creating technology from scientific research and development work to serial production and operation;

4) a combination of the target orientation of research, development and production for a competitive result with promising areas of work for a system-wide, fundamental purpose;

5) high dynamics of production, manifested in the constant updating of its elements (objects of research, development and production, technologies of circuit and design solutions, information flows, etc.), changes in quantitative and qualitative indicators, improvement of the scientific and technological structure and management. The dynamism of production over time complicates the task of uniform loading and use of IIM;

6) active and efficient investment and innovation (in production, the rate of renewal of the active part of fixed assets should reach 10–13%, in the scientific and experimental base – 30–40% per year, which corresponds to global practice);

7) a high share of highly qualified scientific, engineering and technological and production personnel in the total number of employees;

8) the presence of unique scientific schools and experimental design teams capable of creating products that are competitive in the world market, maintaining leadership in the development of the necessary scientific directions and technologies;

9) aggressive marketing policy in promoting its products, ensuring the conquest and retention of strong positions in the domestic and world markets, the inflow of financial resources necessary for the development;

10) an effective system for ensuring (including legislative) intellectual property rights;

11) the presence of an effective system for the dissemination of innovations, the predominant use of advanced technologies throughout the life cycle of development and production.

In accordance with these features, the IIM of Ukraine primarily includes the branches of the defense complex, including aviation, rocket and space, nuclear, radioelectronic, shipbuilding, as well as a number of civil (pharmaceutical, biotechnological, production of composites, scientific instrument making, production of complex medical equipment, etc.).

A general description of the current state, processes and trends in the development of knowledge-intensive industries against the background of structural changes that took place in the Ukrainian economy in the 2000s is given in a number of works [for example, 13; 17; 21].

In [17], based on the research methodology of long-term technical and economic development as a process of successive replacement of technological structures [21], qualitative and quantitative assessments of the regressive shifts that occurred at this time in the technological structure of the economy are given. With regard to knowledge-intensive industries, we note that the loss of reproductive integrity and the dominance of reproduction circuits external to it in the economy, which is characteristic of colonial countries, means not only the loss of economic independence, but also the disappearance of internal sources of sustainable economic growth. The destruction of our own scientific and technological potential, a sharp reduction in the scale of research and development, the disintegration of technological chains that ensure the closure of innovation cycles – this is the loss of opportunities to use the main source of such growth – scientific and technological progress. All that remains is to consume its results generated abroad, while simultaneously paying a huge intellectual rent for their use, exporting natural resources and raw materials for this.

The measures taken to reform the Ukrainian economy did not contribute to the positive direction of its restructuring, on the contrary, there was a clear tendency of degradation of the existing high-tech potential, a reversal of the trend of its gradual growth and a landslide reduction both in absolute value and in relation to other less developed sectors of industry: there was a "rollback" the potential to its value 30 years ago.

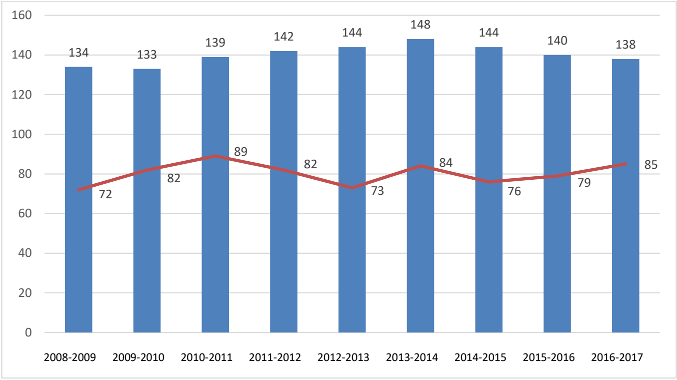
The result of the imbalance in the structure of IIM in favor of specific, highly specialized defense technologies was that under the influence of the policy of "shock therapy" these industries found themselves in a critical situation – there were acute problems of a radical reduction in government orders, financing, conversion, restructuring and diversification of production capacities. and scientific and experimental base.

As a result of the inability of the government to pay for their orders, the enterprises formed huge accounts payable, which brought more than 80% of defense enterprises to the state of bankruptcy. In the period from 1990 to 1997 alone, the decline in production in the high-tech industries (according to the State Statistics Service) was more than 60%. For certain types of technological complexity of civilian products, over the years, there has been a multiple decline in production or it has been completely discontinued. The degree of wear of fixed assets of mechanical engineering already in 1997 reached 61%.

The innovative potential of IIM is steadily decreasing, that is, the development of new products, new types of machines, equipment, automation equipment, which is reflected in international ratings of innovativeness (Table 2) and competitiveness of the national economy (Figure 1).

Table 2 – Indicators of innovative development indices for Ukraine (Global competitiveness index)

Indicator	2008–2009	2009–2010	2010–1011	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016	2016–2017
number of countries in the ranking	134	133	139	142	144	148	144	140	130
Ukraine's place in the ranking	72	82	89	82	73	84	76	79	85
sub-index "Innovation"	52	62	63	74	71	93	81	54	52
innovative ability	31	32	37	42	58	100	82	52	49
quality of research institutions (institutes)	48	56	68	72	64	69	67	43	50
R&D costs of companies	52	68	69	75	104	112	66	54	68
the relationship of universities with industry in the field of R&D	49	64	72	70	69	77	74	74	57
government procurement of new technologies and products	54	85	112	112	97	118	123	98	82
availability of scientists and engineers	54	50	53	51	25	46	48	29	29
the number of patents received from the USA (per 1 million population)	65	64	64	71	51	52	52	50	49



– total number of countries in the ranking. – Ukraine's place in the ranking.

Figure 1 – Rating of competitiveness of Ukraine (Global competitiveness index)

It should be noted that today in Ukraine there are 40 industrial parks, 26 science parks, 16 technology parks, 24 innovation and technology transfer centers, 22 innovation centers, 38 commercialization centers, 24 innovative business incubators, one investment and technology cluster. more than 30 clusters, one innovation and production institution, start-up schools, incubation programs, an intellectual property center, a center for scientific, technical and economic activities [19, p. 9].

Thus, one of the tasks of the state scientific and technological policy, which is to carry out a controlled reorientation of IIM from fulfilling orders for government needs (mainly defense) to market demand, was not implemented. The adaptive abilities of enterprises for a smooth entry into a spontaneously organized market were not enough in the face of a radical and sharp reduction in the state order for defense and civil the domestic market and the interests of the domestic producer.

Geyets V. draws attention: “Since in the XXI century the vices of public and state life have not changed much compared to previous times, the definition of the innovative content of any projects is relative, and it is not known to what extent the content of innovation meets the demands for necessary changes in modern public life” [3, p. 7].

The financial investment crisis has intensified a number of deformation processes that accelerate the further collapse of IIM and are, judging by their state, intractable. Among them, the following should be highlighted:

a) in fact, there is a deindustrialization of the economy, since the current process of a sharp decline in investment and innovation activity does not ensure reproduction. As a result, the renewal of the active part of fixed assets has almost completely ceased, the process of their depreciation and “consumption” is growing, especially their active part (machinery, equipment), which are the object of innovation. The revaluation of fixed assets does not compensate for the replacement cost, since it is a one-time act for the enterprise, and the prices of products, raw materials, energy, fuel are constantly growing, depreciation does not cover the costs of restoring funds, flows of financial resources are torn off from the real movement of fixed capital, and investors are not interested in production investments. Against the background of the accelerated aging of the fleet of machinery and equipment, this entails a rapid reduction in production and technological potential, available capacities;

b) suppression of demand (the result of a monetarist approach to financial stabilization) and a corresponding lack of orders in the real sector of the economy, lack of profit for enterprises, which is also eaten by high inflation and rising prices for materials, energy, components, etc., high bank rate, decrease depreciation deductions contribute to the fact that even those insignificant internal resources at the disposal of the enterprise do not have economic motivation to maintain production. It is more profitable to direct them to current consumption;

c) a sharp reduction and even complete cessation of funding for fundamental and exploratory research in the field of high technologies hinders the advance creation of scientific and technological reserves – the basis of scientific and technological development. Previously, such studies covered a wide range of areas of modern science at the National Academy of Sciences of Ukraine, higher education, in scientific organizations of the branches of the economy. All this allowed science to reach the forefront in a number of priority areas, including in the field of nuclear and rocket and space technologies. Without scientific and technological groundwork, the country is doomed to lag behind highly developed economies.

It is known that the consistent replacement of technological structures as the basis of scientific and technological development is carried out by creating advanced scientific and technical, design, technological and investment (capital construction) reserves, which are the most important strategic resource for the implementation of the concept of economic development based on the use of intensive factors of economic growth. Prolonged interruption of the reproduction process of these reserves hinders scientific and technological development, and returning to the previously achieved will require many times more forces and resources than is necessary now to maintain and develop the existing reserves.

It should be recalled that Article 48 of the Law of Ukraine “On Scientific and Scientific and Technical Activity” establishes funding for the scientific industry at least 1.7 % of GDP from 2020. Today it is almost ten times lower. Thus, the early created scientific and technological reserves are being depleted and, as a result:

1) the consumption at the R&D stage increases, the quality of products decreases, the terms of development and production increase;

2) the quality of products and services IIM decreases and affects their competitiveness in the world and even the domestic market;

3) the intellectual and human potential of IIM decreases, the number of highly qualified specialists decreases, young specialists do not go to science due to the low prestige of the profession, the average age of workers is growing.

All this negatively affects the potential of the IIM themselves, as well as those spheres of life, for the provision and development of which they were intended. Reduced potential has dramatically weakened the competitiveness of the Ukrainian economy.

In the current economic conditions, the task of the state in the field of IIM is to change the stable trend of reducing the scientific, technological and production potential of industry by increasing the optimal proportions (rates) of investment and innovation activity, removing all obstacles in the way of this process, first of all, promoting the attraction of non-state investments, carrying out effective depreciation and tax policy.

The goal of the Strategy for the Development of the Sphere of Innovation for the Period up to 2030 is to build a national innovation ecosystem to ensure a quick and high-quality translation of creative ideas into innovative products and services, to increase the level of innovation of the national economy [19, p. 9].

To restore the decisive role of IIM as the basis of scientific and technological development, a clear and consistent scientific and technological policy with clearly expressed goals and development of a multichannel financing system, in the adoption of measures to support domestic producers and protect the domestic market.

At one time, initially, in the knowledge-intensive sector of the economy, conditions were created for active investment and innovation, an effective system for the dissemination of scientific and technical innovations functioned with effective control of the growth of the technical level of production and the establishment of responsibility for its provision. In less priority industries, funds for the introduction of innovations were allocated significantly less, therefore the distribution system was less ineffective, which entailed the conservation of obsolete technological structures and the preservation of their diversity. Influenced the diffusion of innovations and the lack of a competitive market environment, the weak susceptibility of a directively controlled economy to scientific and technological progress.

The series of state target programs for conversion and restructuring adopted by the government, as it has not been implemented before, is not being implemented now for two main reasons: a) the state does not have the funds to implement them, because the budget is drained of blood by the barely functioning real sector of the economy, which should to fill it, and b) reliance on bureaucratic methods of structural transformations, and not on creating the necessary conditions for this.

Consequently, in order to ensure continuity in scientific and technological development, it is necessary to look for ways of survival and measures of direct and indirect state support for IIM, which to a greater extent use the internal abilities of IIM self-organization in the conditions provided to them by the possibilities of economic independence, the choice of forms of corporate structure and the integration of forces into struggle for markets. Among such measures of support and disclosure of the possibilities of internal self-organization of production and market regulation of demand, the following can be proposed:

1) expanding the use of financial technologies that are new to our economy, such as leasing, the creation of venture funds, etc., permitting the financing of scientific and technological development by investing part of the income received, which is not subject to taxation, on new developments and production development;

2) the provision of deferrals for the payment of taxes in cases of delay in payment of the state order fulfilled by them;

3) providing buyers (that is, consumers, and not manufacturers, which did not justify itself in practice) of science-intensive products and services of targeted investment tax credits, including syndicated ones, on the basis of their return from the income received from the use of these products and services;

4) the establishment of a procedure that guarantees enterprises that possess the key, most important, so-called critical technologies, a certain share of the profit from the operation and use of their products, released on state orders by highly profitable commercial organizations (for example, operators of communication systems, navigation, etc.);

5) exemption (in whole or in part for a certain time) of science-intensive industries from paying taxes to the state and / or local budgets if this measure counteracts the decline in production, contributes to the preservation and creation of new jobs;

6) transfer of part of the income received from the use of IIM products, not to the “common pot” of the state budget revenues, but to special accounts for the development of these industries;

7) permission of the state-owned IIM, the sale in accordance with the established procedure of excess liquid stocks of technological equipment and areas for the purpose of their own development;

8) establishing for IIM, which has a large scientific and experimental base in the general structure of fixed assets, such a procedure for taxing fixed assets, land use, etc., which would allow them to direct additional financial resources and investments in fixed assets, thereby maintaining competitiveness in the domestic and foreign markets;

9) changing the current procedure for bankruptcy procedures and terminating bankruptcy procedures in relation to high-tech enterprises and industries, primarily working in the interests of defense, since this destroys the existing technological cooperation;

10) protection of those domestic producers who are capable of filling the domestic market of complex products with Ukrainian samples on a qualitatively new basis (first of all, this concerns electronics, other household and office equipment);

11) support of various forms of industrial and financial integration of Ukrainian producers and foreign corporations, provision of protectionist support for the promotion of Ukrainian products on the world market;

12) creating a system for the dissemination of scientific and technological innovations, stimulating the transfer of more advanced technologies from the defense industry to civilian production;

13) the formation and stimulation of effective demand for goods and services as the basis for the restoration of the financial, personnel and scientific-production potential of the IIM;

14) stimulating the retention of highly qualified personnel, training and attracting young specialists.

The listed set of means of support for advanced industries, the art of using which in various combinations must be learned to master, must be supported by measures to support the real sector of the economy at the macro level, such as improving the financial system and bringing the bank interest rate on loans to an acceptable level for long-term investments, reforming the tax system in the interests of domestic producers, the approximation of the hryvnia exchange rate to its real purchasing power, etc.

Otherwise, the real threat of the complete degradation of IIM, the irreversible loss of their potential, created by the labor of many generations, will pose a direct threat not only to the economic, but also to the national security of Ukraine in general. The future place of our country in the international division of labor, in what capacity Ukraine is integrated into the EU: as an exporter of raw materials and importer of machinery, equipment and goods or as an industrialized country with advanced industry and science.

Thus, the analysis of the prerequisites for the emergence and forms of manifestation of SD threats allows us to draw the following conclusions:

1) the SD problem is sharply exacerbated and becomes most relevant during periods of instability in the socio-economic development of society. One of the main consequences of political and economic instability is a decrease in investment activity in the financial market due to the high risk of financing capital investments or the absence of their sources. The sustainability of the development of a large technical and economic system, which is IIM, is one of the main conditions for its predictable behavior and safety, reducing the level of uncertainty and risk when making operational and strategic management decisions;

2) SD IIM, on the one hand, is inseparable from the SD of the country as a whole to the same extent as this production itself is integrated into the general structure of the sectors of its economy, and, on the other hand, it is directly dependent on the state of its own potential and efficiency managing it;

3) to reduce the level of risks in decision-making and threats to economic security, IIM needs to have and develop adaptive capabilities that allow it to quickly adapt its potential to changing market demand requirements and business conditions;

4) effective risk management, their minimization IIM requires knowledge and skills to adequately and reasonably assess from the SD point of view your current state and predict its development in the near and long term.

4. METHODOLOGICAL BASES WORK FOR ASSESSMENT OF SECURITY-ORIENTED DEVELOPMENT OF INNOVATIVE-INVESTMENT MANUFACTURE

4.1 CLASSIFICATION OF THREATS TO SECURITY-ORIENTED DEVELOPMENT

The problem of SD of an enterprise has many objects of special attention of experts due to the multiplicity of elements of the organizational and economic structure of IIM and the complexity of their interaction, as well as due to the variety of possible forms of manifestation of economic risks and methods of countering various threats. In accordance with the functional properties of the interrelated elements of this structure, it is necessary to consider the following areas of its activity as potentially subject to threats and real damage, and, consequently, as objects of measures to prevent or neutralize SD to an enterprise:

- state of production and technological potential;
- state of scientific and technological potential;
- state of human resources;
- management activities;
- financial resources and cash flows;
- investment activities;
- maintaining competitiveness and demand;
- information and computer networks;
- cooperation ties and logistic support;

- regulatory support;
- institutional support (property rights);
- ecology;
- protection from a pandemic;
- protection from man-made manifestations;
- protection from natural manifestations;
- protection from criminal manifestations.

The production and technological component of SD is manifested in the need to preserve and develop the created production and scientific and technological potential of the enterprise, in the sustainability of its production capabilities, in the ability to promptly respond to the changing requirements of the market for goods and services.

The scientific and technological component of SD is manifested in maintaining at a high level the scientific, scientific, technological and design potential of the enterprise, its research and experimental base, in the enterprise's ability to actively innovate and invest, that is, in the ability to create and implement innovations, acquire patents, create products that surpass competitors' products in terms of their scientific and technical level and consumer properties.

The personnel component of SD means taking care of the quantitative and qualitative composition of the personnel potential, the enterprise – its number, age and qualified structure. To ensure SD in this area of activity, the enterprise must solve the problems of retaining existing highly qualified workers, modern training of new personnel and improving their qualifications. Working conditions and social security of workers should be no worse than at other enterprises.

The managerial component of SD is manifested in the impeccability and efficiency of the company's management, in the high qualifications and competence of management personnel, in the perfection of the structure of the enterprise and the structure of its management, in the adequacy of control reactions to the conditions of the external environment of the enterprise.

SD in the field of finance and cash flows of an enterprise is manifested, firstly, in the necessary financial support of the enterprise's activities (finance is one of the main resource factors of this activity), and secondly, in the efficient use of financial resources remaining at the disposal of the enterprise after taxes, thirdly, in reducing risk factors in the implementation of financial transactions, fourthly, as a forecast of cash flows, fifthly, in the distribution over time of receipts and expenditures of funds, sixthly, in accounting for inflation – a general increase in prices in the economy, and etc.

The investment component of SD is manifested in the ability of the enterprise for economic growth and expanded reproduction, in taking into account risk factors and uncertainty in investment design. Such abilities are ensured, firstly, by the ability of the enterprise to earn the necessary funds or borrow them in the credit and financial market and, secondly, by the efficient use of investment resources. An enterprise's lack of these resources or their inept use entails a low level of innovation and investment activity, threatens stagnation in production, moral and physical aging of fixed assets, especially their active part – machines, equipment, mechanisms, etc. At the same time, the innovation and investment program of an enterprise should not "overburden" its economy, being reflected, for example, in a sharp increase in the cost of production or, conversely, in a decrease in the level of staff income, etc.

The SD component in the field of maintaining competitiveness and demand is manifested in the ability of an enterprise to develop and conduct competitive products, pursue an aggressive marketing policy in the markets for goods and services (internal and external), promptly create and develop sales and distribution networks for its products, create advanced scientific and technological, investment (capital construction) reserves for the development and mastering of new technologies and new products.

The information component of SD is manifested in the security of information, computer networks and communication facilities of the enterprise from unauthorized access, in preventing the leakage of valuable commercial and scientific and technical information, in protecting programs for computer technology from computer viruses, in reducing staff turnover, especially associated with his departure to competing enterprises, etc.

The SD component in the field of production cooperation and logistic support is manifested in the creation of a reliable, stable system of timely deliveries and the creation, if necessary, of an optimal warehouse stock of components, raw materials, materials and semi-finished products to ensure a rhythmic production process.

The SD component in the field of regulatory and legal support is manifested in strict adherence to legislation, instructions and other acts regulating the economic and other activities of the enterprise, in the presence of a high legal culture among managers and personnel of the enterprise, which is manifested in the proper execution of contractual relations with counterparties, in compliance with patent and the licensed purity of the products of the technologies used, in the ability to defend the interests of the enterprise by legal methods (through court, arbitration), including in the protection against unfair competition (illegal use of a trademark, violation of intellectual property rights, industrial and economic espionage, false information, discrediting the business reputation of an enterprise, its products, production or commercial activities), etc.

The institutional component of SD, that is, ensuring property rights in the enterprise, manifests itself in the correct (in accordance with the current legislation) in the timely registration and consolidation of ownership rights to property, other assets of the enterprise, as well as to the results of its activities, in responsibility for these results.

The environmental component of SD is manifested in the implementation of environmental protection measures, in compliance with the norms of emission of harmful substances into the atmosphere, in water basins, on the soil, in the creation of a system of environmental control over the activities of the enterprise.

The SD component associated with the fight against the emergence of various pandemics (such as SARS-Cov-2) is manifested in the development of operational measures (development of appropriate vaccines, training of medical personnel and provision of everything they need, etc.) and the behavior of the necessary budgetary support. In 2020, a difficult situation has developed, which is associated with the coronavirus and the economic crisis. At the same time, the government claims that there is a planned deficit of 7.5 % of GDP, which has been agreed with the IMF.

The man-made component of SD is manifested in compliance with the norms of industrial safety legislation, in the protection of personnel and material assets from man-made manifestations (accidents, disasters, accidents, etc.).

The natural component of SD is manifested in the presence of a warning system about an impending natural hazard, in the protection of the entire enterprise, technological processes, infrastructure, and personnel from natural disasters.

The anti-criminal component of SD is manifested in the protection of the economic activity of the enterprise from criminal manifestations of persons aimed at generating income in violation of the current legislation or associated with gaps or shortcomings in it, in the prevention of life-threatening impact on the personnel of the enterprise, etc.

As can be seen from the above characteristics that make up the SD of the enterprise, all these factors closely interact, they are interdependent and interrelated.

In accordance with the listed areas of activity of the enterprise, it is possible to classify the threats to its SD: according to the form of manifestation (explicit and latent), according to the intensity of manifestation (active or passive), if possible, foresight (predictable or accidental), according to the amount of damage, according to the object of encroachment, according to the nature of occurrence, by the place of origin (internal and external).

4.2 INDEXES AND INDICATORS OF SECURITY-ORIENTED DEVELOPMENT

As noted above, the concept of SD, due to the variety and scale of the manifestation of threats at various levels of the organizational structure of the economy, has significant specific differences not only in the semantic definition, but also in the composition of the indicators that characterize it.

From the accurate identification of threats, from the correct choice of indicators for their manifestation, that is, the system of indicators for monitoring (they are also called indicators), the degree of adequacy of the SD assessment of the existing reality in production and the adoption of the necessary measures to prevent and counter threats, corresponding to the scale and nature of threats, depends.

So, to characterize the SD of Ukraine, a fairly complete and representative system of macroeconomic indicators is used [6, p. 431–433], reflecting the economic situation of the country, the use of its potential, the quality of life of the population, etc. The key parameters of the SD of Ukraine are obviously related to the dynamics of production, the state of the budget and the state debt.

One of the goals of SD monitoring at the industry level is to diagnose the state of a specific industry using a system of indicators that take into account specific industry characteristics and are most typical for this level.

If you use a similar technique to build a system of quantitative and qualitative SD indicators at the level of a science-intensive industry, corporation, enterprise, then, in our opinion, it is necessary to include the following indicators (naturally, this list requires its specification for each type of production, ranking indicators for the main and minor):

a) financial indicators:

– the volume of the "portfolio" of orders (the total volume of estimated sales);

– actual and required volume of investments (to maintain and develop the existing potential);

– level of innovation and investment activity (volume of investments and innovations);

– the level of production profitability;

– capital productivity (capital intensity) of production;

– overdue debt (accounts receivable and payable);

– share of provision with own sources of financing of working capital, materials, energy for production;

b) production indicators:

– dynamics of production (growth, decline, stable condition, rate of change);

– the real level of utilization of production capacities;

– share of R&D in the total scope of work;

– the share of R&D in the total production of the latest products;

– the rate of renewal of fixed assets (renovation);

– stability of the production process (rhythm, level of workload during a certain time);

– share of production in GDP;

– assessment of the competitiveness of products;

– age structure and technical resource of the machinery and equipment park;

c) social indicators:

– the level of wages in relation to the average indicator for industry or the economy as a whole;

– the level of wage arrears;

– loss of working time;

– structure of human resources (age, qualification).

The main reasons for the emergence of threats to the SD of an economic entity are low competitiveness, and therefore the lack of demand for products on the market, the inability of the state to pay for products for its needs, the instability of the financial situation of enterprises, an unfavorable innovation and investment climate, a high level of inflation, etc.

4.3 CLASSIFICATION AND ASSESSMENT OF SECURITY-ORIENTED DEVELOPMENT

With regard to the specifics of the enterprise and in accordance with the actual and standard values of its technical and economic indexes and the magnitude of their deviation from the barrier (threshold) values of indicators, the SD state of this enterprise is sufficiently characterized by four grades of assessment:

a) normal when the SD indicators are within the threshold values, and the degree of utilization of the available potential is close to technically sound standards for equipment and area utilization;

b) pre-crisis, when the value of one or several (say, up to three) SD indicators approached a certain neighborhood of their barrier values (that is, fell into the "danger zone" of production) and at the same time the technical and technological possibilities of improving the conditions and results of production by adopting a preventive threat;

c) crisis, when the barrier value of at least one of the SD indicators is crossed or the value of four or more indicators, although they find themselves in the "danger zone", still do not exceed their barrier values, and there are signs of an irreversible decline in production and partial loss of potential due to the exhaustion of the technical resource of the equipment and areas, staff reduction;

d) critical, when all (or almost all or most) barriers separating the normal and crisis states of production development are overcome, and a partial loss of potential becomes inevitable and inevitable.

Let P_i be a system of indexes SD of production, i = 1, ..., m; p_i^6 – threshold (barrier) normalized value of P_i indexes

Changes in the xi values of the Pi indicator occur in the range $0 \le x_i \le 1$ and these values, in accordance with the accepted gradation of assessments, are determined by the ratios:

$$x_i \begin{cases} x_i^n, \text{ if } (1+\delta)p_i^6 < x_i \le 1; \\ x_i^{pc}, \text{ if } p_i^6 < x_i \le (1+\delta)p_i^6; \\ x_i^c, \text{ if } p_i^6 \le x_i < (1-\delta)p_i^6; \\ x_i^{cr}, \text{ if } 0 \le x_i < (1-\delta)p_i^6. \end{cases} \quad (2)$$

Here δ is the neighborhood of the barrier value of the index, which takes a value, for example, δ = 0.15; the state of production is indicated as follows: n – normal, pc – pre-crisis, c – crisis, cr – critical.

There are various methods and approaches for diagnosing and determining the integral index SD, which characterizes the effect of heterogeneous threats on the state of the enterprise [1, p. 35–37].

Using the graphical approach shown in Figure 2, then the condition $S_n \ge S_{pc} \ge S_{cr}$ will serve as such a criterion for the state of production that meets the requirements of SD, where S_n is the area of the polygon during normal or pre-crisis development of production; S_{pc} – the area of the polygon in the crisis or threshold zone of the state of production; S_{cr} – the area of the polygon in the critical zone of the state of production. The delta-neighborhood of the threshold values of indicators determines the "hazard band" of production in the interval $\left((1++\delta)\,p_i^6,(1-\delta)\,p_i^6\right), i=1$, .., m.

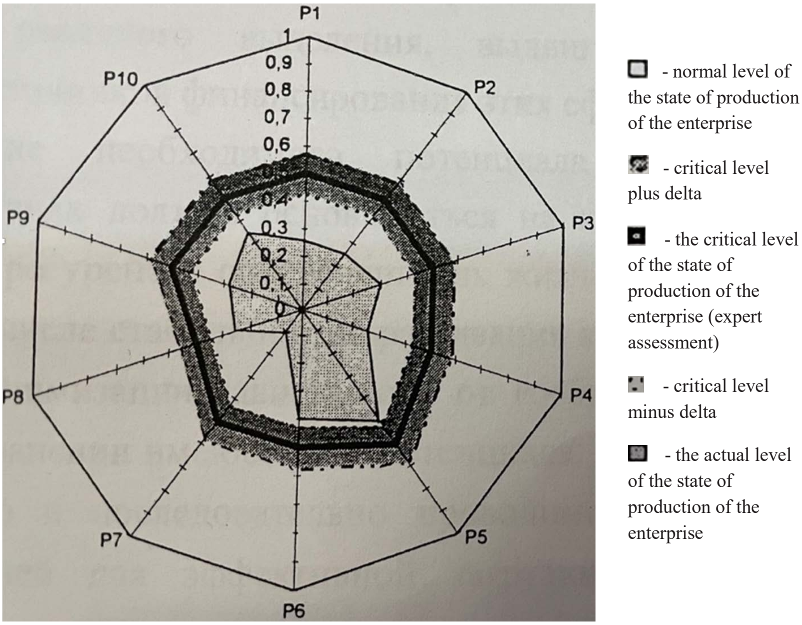


Figure 2 – Diagram of indexes of security-oriented development

As an example of a qualitative analysis of SD, consider the science-intensive engineering industry, characterized by the following system of SD indexes under normal conditions of its functioning, threshold parameters (index values) of the critical state level and indexes of the actual state (Table 3).

To assess deviations, the values of indexes are normalized relative to the values of indexes of the normal functioning of production, taken as a unit, the threshold values of SD indexes and the values of indexes of the actual state of production are calculated in fractions of this unit. Then, for example, the standard for the use of production capacity at full load in a stationary mode of production is equal to one, and the threshold value of the index for the critical level of economic security is 0.5, while its actual use is 0.25.

Table 3 – Indexes of security-oriented development of the enterprise

Indexes (indicators) SD of the enterprise		The value of the index in the normal state of production, %	Normal production status	Critical level of the state of production (expert assessment)	Actual production status
The volume of financing of working capital, etc.	P_1	100	1	0,5	0,25
Capacity utilization rate	P_2	100	1	0,5	0,25
Production profitability level	P_3	100	1	0,5	0,3
Share of R&D in the scope of work	P_4	40	1	0,5	0,25
Share of R&D work in the total volume of R&D	P_5	20	1	0,6	0,5
The level of wages to the average for the industry	P_6	150–200	1	0,5	0,4
The rate of renewal of fixed assets	P_7	10–13	1	0,5	0,1
Share of employees over 50 years old	P_8	20	1	0,4	0,25
Specific weight of equipment with a service life of up to 10 years	P_9	70	1	0,5	0,28
Return on assets	P_{10}	100	1	0,5	0,35

The system of indexes of the actual state was compiled by the authors on the basis of averaged data on the results and operating conditions of science-intensive industries available in print [1; 6; 16].

The normative, actual and threshold values of indexes characterizing the age and qualification composition of production workers, the age structure of the equipment park were determined as follows (Table 4).

The diagram of SD indexes and indexes characterizing the real state of IIM is shown in Figure 2.

Since the capacity utilization indexes and many others do not exceed 30 % of the norm, then when the actually financed work is performed, this production will be in the zone of a critical or, at best, a pre-crisis state of IIM.

Table 4 – Additional indexes of security-oriented enterprise development

Index	Index value	Condition assessment	State characteristic
p_8	1,0	normal	20 % of the IPP population is over 50 years old
	0,25	actual	80 % of the IPP population is over 50 years old
	0,40	critical	50 % of the IPP population is over 50 years old
p_9	1,0	normal	70 % of the equipment fleet is less than 10 years old
	0,28	actual	20 % of the equipment park is less than 10 years old
	0,50	critical	35 % of the equipment fleet is less than 10 years old

Consequently, he is faced with the task of finding such a volume of commercial orders (the lack of funding) that will bring the industry to a higher level of production.

The degree of survivability of IIM in crisis conditions turned out to be quite high, and therefore many predictions about the termination of their vital activity did not come true. The fact is that the possibility of survival of these industries is determined by the competitiveness of the products, which, in turn, depends on the level of domestic prices for products and services.

Domestic prices are influenced by two groups of main factors: 1) the costs of creating scientific and technological reserves, staff salaries, depreciation deductions; 2) prices for consumables – raw materials, semi-finished products, components, etc.

The degree of influence of the first group of factors on the level of domestic prices is constantly decreasing, while the second group of factors is growing, since prices for fuel and energy resources, many semi-finished products and components have approached or already exceeded the level of world prices.

The critical moment will come when IIM products become completely uncompetitive in the domestic and foreign markets. So far, such a moment has not yet come, but in 2020 the production of science-intensive products has come very close to the limit when it will remain unclaimed and may cease to function.

The deficit of state budget expenditures for state needs in the field of new technologies, multiplied by the practice of permanently reducing their actual allocation, brings to the fore the search for alternative sources of financing for these areas of activity.

Maintaining the necessary potential of IIM in modern conditions should be based on a comprehensive solution to the problem of multichannel resource support for their life from various sources, including a stable increase in the commercial sector, which will help to minimize dependence on state budget funding while maximizing the preservation of the existing potential. At the same time, it is necessary to take into account the possibilities of a clearly and consistently carried out structural transformation of knowledge-intensive industries for efficient loading of enterprises, improving their financial and economic situation and increasing competitiveness.

The conquest of new markets for their products as additional sources of funds is necessary to compensate for the deficit of state budget financing and bring it to the level of threshold values of SD indexes of industries, below which irreversible degradation of their potential begins, at which the very formulation of the SD assessment problem loses its meaning.

4.4 ECONOMIC AND MATHEMATICAL MODELING OF THE CALCULATION OF TECHNICAL AND ECONOMIC INDEXES FOR THE DEVELOPMENT OF THE POTENTIAL OF INNOVATIVE-INVESTMENT MANUFACTURE

A. Conceptual framework for modeling the development of the potential of innovative-investment manufacture

The identification and adoption of measures aimed at preventing SD threats involves the analysis of the hypothetical state of IIM as a result of the implementation of previously adopted strategic economic and scientific and technological decisions for this production, general trends and processes of demand for products and services, investments, etc.

Since the manifestation and action of threats is not a one-time act, but a complex dynamic process, and the process is deterministic, that is, with a rather rigid temporal structure of causal relationships of events occurring in IIM, then the SD assessment should be carried out in the dynamics of changes in the potential of this production at some the time interval, which should be determined based on ideas about the reliability of the information used as a forecasting base (technically and economically sound standards, norms, etc.). Accordingly, for control points of forecasting (say, at the end of each year or at the end of the entire period), it is necessary to calculate the technical and economic indexes of the state of production, which are the basis of such an assessment.

For the construction and comprehensive technical and economic assessment of hypotheses or possible strategies for the development of production at the control points of the established forecasting horizon, an appropriate toolkit is needed, which can be various methods and models used in economic and scientific and technological forecasting.

What type of model is it advisable to choose to take into account the meaningful aspects of predicting the state of IIM and calculating technical and economic indexes?

The conditions of functioning, changes in the state and specific features of IIM, given in Part 3, reflect most fully the imitation models due to an adequate description of the realistic states of economic entities and production processes throughout the entire life cycle of products, also the actual course of the production process and their representation with the help of some fairly complete and specific set of control parameters and technical and economic indexes is a prerequisite for the construction of imitation models [1, p. 40]. In the case under consideration, these conditions are achieved.

The main advantage of the imitation model is its "imitation", the accuracy of its compliance with the real process of production, planning and management.

The imitation model of IIM functioning and predicting its development strategies meets the requirements of management adaptability to changing (external and internal for a large technical and economic system) economic factors and conditions, which makes it possible to objectively assess the scientific and technological potential of this production, its financial condition, determine profit and size own funds for development and economic incentives, depending on orders and planned scope of work, to explore areas of specific and targeted development of the specified potential, to minimize risks and possible damage. Another defining advantage of it is that it is always dynamic in its meaning, since in any description of the process of development of an economic object, time is always explicitly and implicitly present.

In addition, the imitation model is convenient for organizing interactive interaction with the manager, which, in turn, in conditions of uncertainty and non-formalization of a number of external and internal factors of IIM (completeness and rhythm of financing, the effectiveness of research and development, scientific and technological risks, etc.), nevertheless, allows for multivariate calculations, comparison of various options, and solving the problem of choosing the best one.

The use of imitation modeling to study the state of IIM allows one to present the dynamic process of enterprise development in the form of a detailed and consistent description of their economic and organizational state throughout the forecasting period and with various development strategies. These models can naturally take into account the nonlinearity of a number of parameters and technical and economic indexes of production activities, which is dictated primarily by the discrete nature of the demand for products, the commissioning of new capacities, the gradualness of their development during the standard period, the different timing of costs for increasing capacities and developing infrastructure, other individual characteristics of production.

The imitation method provides the manager with greater independence in taking into account the factors of production development in the process of modeling and implementing methods for solving certain problems, which allows the manager to concentrate his pragmatic interest on identifying the actual nature of the interrelationships of the production process under study, which is achieved through the formation and analysis of various development strategies.

Market reforms in the Ukrainian economy have made radical transformations in the institutional framework of IIM, respectively, the organizational and functional structures of the management system have changed, the technological structure of the scientific and production potential, which has become redundant, the staff, the system for providing orders for products and services, the financing scheme, the symmetry of production and reproductive processes, etc.

The development of IIM is determined, firstly, by the intensity of reproduction of fixed assets and, secondly, by the system of goals, incentives and economic relations of business entities. For an adequate description of the development of such industries, all of the above elements must be taken into account when modeling.

At the same time, a number of conceptual provisions of the feasibility study for the development of IIM have the property of invariance (neutrality) to these factors. First of all, these should include, for example, the methodology for assessing the production capabilities and capacities of business entities, the directions for the development of their reproductive structure, and others, on which the formation of a strategy for the development of production potential for specific contracts or their absence is based.

Modeling of IIM development strategies is carried out taking into account orders and demand constraints, primarily in terms of supply volumes in value and physical terms in accordance with existing or expected orders (contracts) and market conditions.

The feasibility of a "portfolio" of IIM contracts in a market economy depends on its balance with two other fundamental factors of production:

1) with the state and prospects for the development of production capacities, that is, with the process of reproduction of fixed assets;

2) with the volumes and sources of financing both the contracts themselves and the development of production potential, that is, with capital investments.

The first factor is rather conservative and its consideration when constructing a forecast presupposes the presence of blocks of nomenclature-volumetric characteristics of orders in the structure of IIM functioning models; development of production facilities, investment support, management of the formation of development strategies with a set of parameters for such management.

The second factor is associated with institutional changes in the status of IIM (whether it is state property, joint stock with mixed capital or fully privatized, private), the resulting features of its financial support and methods of managing financial and material resources.

The investment process is a determining factor in the state and strategic planning of IIM development. Differentiation of the forecast for the development of production by sources and amounts of financing is associated with the flow of real money, which must be taken into account when modeling.

The main sources of innovation and investment activity of IIM are as follows: own funds (retained earnings), depreciation deductions, budget funds for the implementation of targeted scientific and technological programs, extra-budgetary funds on a repayable and irrevocable basis, loans, leasing, issuance of securities.

At the stage of predictive assessment of the state of IIM, the sources of financing are not so much important, although they are projected in advance, as the correct determination and justification of the total value of the required investments in the dynamics by years of the forecast period. More detailed calculations of the flow of real money are made at the stage of specific selection and assessment of the implementation of individual projects, when the problem of optimal management of investment resources is being solved.

IIM potential development forecasting models are designed to calculate the trajectories of their functioning during the forecast period. The state of IIM in each year should be characterized by a system of technical and economic indexes (TEI), and the trajectory by listing the values of these indicators in the base year and by years of the forecast period. Based on the indicators, an analysis is made of both the development of production, set by the trajectory, and the comparison of trajectories with each other. Each trajectory represents an alternative variant of forecasting the development of scientific and production potential of a business entity, where the variant of forecasting development is understood as a sequence of potential states with a certain quantization period.

To develop a specific model for assessing the potential of production, it is necessary to identify the main factors that determine its capabilities and technical and economic indexes that sufficiently fully characterize the state and dynamics of potential development. The Institute of Economics and Forecasting of the National Academy of Sciences of Ukraine develops the concept of jointly divided activity: the development of relations of separation is embodied in the division of labor, private property and market institutions, and relations of jointness – in cooperation and socialization of labor, public property and state institutions [4, p. 15].

One of the main factors in science-intensive mechanical engineering is the synchronization of intensity and the achievement of a balance of production and reproduction processes. The reproduction structure of capital investments should include technical re-equipment, reconstruction or expansion of the enterprise, the construction of separate facilities at the operating enterprise, which are an integral part of the technological support for the production of specific types of products (we will call them special facilities – special-purpose facilities).

These factors should also include the state of labor productivity (its change at different rates in different periods of time).

Technical and economic indexes characterizing the development of IIM can include several types of data:

1) initial data on the baseline state of production, including information on the commenced measures for construction, reconstruction, expansion or technical re-equipment;

2) economic standards that meet the requirements of intensive, economical management of the economy – tasks to reduce production costs, standards for the duration of construction, reconstruction and development of newly commissioned capacities;

3) indexes reflecting the goals of production development and, above all, demand, orders for the release of products, its cost and prices, projected sales volumes, profit;

4) data on started production development projects, information on special-purpose capital construction projects, the introduction of which is caused by the use of new equipment or technology, as well as data on hypothetically possible ways of development;

5) data on the volumes and sources of funding for reproduction (at present, such sources are mainly own funds, other sources, such as borrowed funds, leasing, the issue of shares and bonds, are used to a minimum extent for various general economic reasons or not used at all).

The model, reflecting various strategies for the functioning and development of production, at the same time should contain for each of them the calculation of such a set of technical and economic indexes that allows for a variety of quantitative and qualitative assessments of development alternatives (including for their comparative assessment among themselves). The methodological basis for such a calculation of indexes should be general methodological principles, rules and recommendations for all industries, reflecting the specifics of production and planning in each specific industry, including the system of pricing and financing.

Each version of the forecast for the development of production should cover a long period (up to 10–15 years) and therefore include various measures to change its production capabilities, which are strategic for these industries. In order to accommodate such changes, certain model conventions must be followed, such as:

– the construction of facilities should be provided only if the change in potential through organizational and technical measures for technical re-equipment is impossible. Organizational and technical measures should be provided on the condition that the removal of products from one 1 sq. m. total production area does not exceed the standard;

– measures for the construction, reconstruction, expansion or technical re-equipment of production must be completed, and their capacities mastered within the specified time frame;

– special facilities should be taken into account in any capacity development strategy as integral components of the product life cycle.

The choice of specific combinations of factors depends on the specifics of the state of production in the base year, the availability of a project or an ongoing development program in the forecast period, as well as on orders for the production of products – in what volume, with what structure, at what time it is required to change production capacity.

B. Scheme for constructing strategies for the development of innovative-investment manufacture

The states and development strategies of IIM formed with the help of the imitation model should take into account:

1) organizational and technical measures to maintain production capacity and technical re-equipment of varying intensity;

2) construction, commissioning and development of individual production facilities (production modules of a certain capacity), due to the need to increase production;

3) retirement of capacities due to reduction or re-profiling of production.

A separate production module of a certain capacity is understood as a hypothetical capital construction facility for industrial purposes with certain design characteristics (design capacity, estimated cost, construction and development time, etc.). Having a parametric series of such universal modules of various capacities and connecting them sequentially to the existing production capacity, it is possible to calculate options for design production indexes with a capacity deficit (existing and newly created) identified in the process of such a calculation. The module plays the role of a kind of compensator for the lack of capacity, the timely commissioning of which would allow to “expand” production bottlenecks and fulfill government orders, other contractual obligations, and meet the projected growth in demand for products.

The introduction of an element of the “production module” type into the model structure allows a priori, using the effect of bench imitation, to carry out analytical calculations of the feasibility of demand, including contractual obligations and government orders. Thus, these calculations not only answer the question of the possibility of meeting demand, the feasibility of contracts (existing and anticipated), but also allow you to determine a strategy for achieving demand goals in the event of a lack of capacity by hypothetical growth and predict the results (technical and economic indexes, investment volumes and other production resources) to implement each strategy. For industries of each industry profile (mechanical engineering, instrument making, etc.), reflecting the specifics of their fixed assets, a parametric row of production modules of various capacities is required. In addition, in the structure of the model, in accordance with the above possible strategies, a system of control parameters and progressive technical and economic norms and standards is required, which makes it possible to form various options for the development of production, depending on the nature of the control parameter and the law of its change in the specified interval.

It is advisable to include the following indicators into the system of model control parameters: average annual rate of change in labor productivity in the forecast period (minimum and maximum); production capacity and terms of commissioning of production facilities; production capacity and timing of commissioning of individual production modules; planned volume of production in value terms by years of the forecast period.

The system of norms and standards, which is the calculation basis for the strategic planning of production development, must include the norms of tax deductions and distribution of profits for the formation of enterprise funds; labor intensity standards for the manufacture of products (performance of work); normative removal of products from 1 sq.m. the total area of the enterprise; standard coefficients of utilization of production capacities, shifts of equipment operation; standards for the development of design capacities; specific capital investments per 1 thousand UAH of annual increase in production output and others.

And, finally, the last constituent element of the model is a system of technical and economic indexes characterizing the variant of production development, and their calculation formulas. A comprehensive assessment of the option and the corresponding production development strategy is possible only on the basis of a sufficiently complete and representative set of indexes characterizing the option. To this end, the model should contain the calculation of the necessary indexes with the possibility of their expansion. The indexes should be calculated depending on the development strategy of production in dynamics and unambiguously depend on the control parameters. In the structure of the variant, the manager needs to have indexes:

– production, its financial position and security, including sales volumes and gross output of products in the species structure in value terms, production costs, the cost of raw materials, materials and purchased components, etc.;

– the estimated need and use of capital investments and capital construction, including calculations of the required volumes of capital investments for technical re-equipment, reconstruction and expansion of existing production facilities, commissioning and disposal of industrial and production fixed assets, terms of commissioning facilities, volumes of construction in progress;

– production capacity, including capacity utilization factors, an increase in production capacity in terms of the reproductive structure, taking into account the norms for the development of newly commissioned capacities, the use of equipment and assembly areas, etc.;

– economic efficiency, including the growth/decline rates of production and labor productivity, the use of fixed assets, the payback period of investments, the share of the increase in production due to the increase in labor productivity, the intensity of the plan for labor intensity, data on the cost price, profit, profitability of production;

– for labor and personnel, including the calculation of the required number of industrial and production personnel, the labor intensity of the production program, the wage fund.

C. Forecasting indexes of the potential of innovative-investment manufacture based on imitation of its functioning

Formation of a variant of the production development strategy and the calculation of its technical and economic indexes should be carried out in stages.

Stage 1. Based on the data of the baseline state of production and a set of control parameters (for example, the rate of growth of labor productivity, the proportion of purchased components and semi-finished products), the estimated volume of production by years of the forecast period is determined. At the same time, the volume of output from newly commissioned capacities is taken into account, if such commissioning is expected. The estimated volume of production should not exceed the maximum possible volume of output, calculated on the basis of the normative removal of products from 1 sq. M. the total area of the enterprise.

Stage 2. If the estimated volume of production exceeds this value, then it is necessary to select from a parametric series of typical production modules such (taking into account the terms of its commissioning and development of capacity) in order to increase production capacity and eliminate the excess.

Stage 3. The volume of investments in fixed assets required for production in the forecast period is determined based on:

- the standard of specific capital investments for the increment of the unit of value of the gross volume of production,
- capital investments to maintain existing capacities,
- capital investments in already ongoing construction,
- capital investments in the production module and other facilities.

Stage 4. Based on the norms, standards, baseline indicators, demand restrictions, concluded contracts, technical and economic indexes of the production development option are determined.

A detailed consideration of modeling strategies for the development of a separate production due to the cumbersome description of models for all of the above strategies will be carried out on the example of one case, namely a development strategy, which is based on organizational and technical measures for the technical re-equipment of production (for other cases, we will designate only the general modeling scheme, generalization of which to these cases presents no fundamental difficulties).

In turn, the strategy of technical re-equipment is multivariate due to the possible control of the degree of intensity of these activities. It can also be achieved in various ways by setting the law (method) of change in the range of values of the key parameter (parameters) of the model, which performs (performs) the function of the control parameter, in the range defined by the manager. The indicator of the average annual growth rate of labor productivity is adopted as such a control parameter in the model under consideration, which quantitatively reflects the intensity of measures for technical re-equipment and the change in the level of technical efficiency of production.

When modeling, one should take into account all possible ways of changing this parameter, which is key for the formed variant: monotonic increase, non-decrease (preservation at the achieved level) and monotonic decrease (Figure 3). Such a law of change in the rate of growth of labor productivity ρ^t, expertly determined by the manager discretely over the years of the forecast period in a given range between the minimum allowable ρ_{min} and the maximum possible ρ_{max} can have the form:

$$\rho^t = \rho_{min} + \frac{q-1}{3} \cdot \frac{\rho_{min} - \rho_{max}}{2} + \left(\frac{q-1}{4} - \frac{q-1}{3} \right) \cdot (t-1) \cdot \frac{\rho_{max} - \rho_{min}}{2}, \quad (3)$$

$$t = 1,\ldots,T, q = 1,\ldots,9,$$

where t – the index of the year of the time period T, equal to five years (T = 5), q – the number of the variant, the square bracket means that only the integer part of the number defined in parentheses is taken into account.

Then for $t = 1,\ldots,T$ we have:

$$\text{for } q = 1 \rho^t = \rho_{min},$$

$$\text{for } q = 2 \rho^t = \rho_{min} + (t-1) \cdot \frac{\rho_{max} - \rho_{min}}{8},$$

$$\text{for } q = 3 \rho^t = \rho_{min} + (t-1) \cdot \frac{\rho_{max} - \rho_{min}}{4},$$

$$\text{for } q = 4 \rho^t = \frac{\rho_{max} + \rho_{min}}{2} - (t-1) \cdot \frac{\rho_{max} - \rho_{min}}{8}, \quad (4)$$

$$\text{for } q = 5 \rho^t = \frac{\rho_{max} + \rho_{min}}{2},$$

$$\text{for } q = 6 \rho^t = \frac{\rho_{max} + \rho_{min}}{2} + (t-1) \cdot \frac{\rho_{max} - \rho_{min}}{8},$$

$$\text{for } q = 7 \rho^t = \rho_{max} - (t-1) \cdot \frac{\rho_{max} - \rho_{min}}{4},$$

$$\text{for } q = 8 \rho^t = \rho_{max} - (t-1) \cdot \frac{\rho_{max} - \rho_{min}}{8},$$

$$\text{for } q = 9 \rho^t = \rho_{max}.$$

Labor productivity for each development option is determined by the chain method according to the formula:

$$P^t = P^{t-1} \cdot P^t, \qquad t = 1,\ldots,T. \quad (5)$$

The nature of the trajectories of changes in labor productivity P^t in the implementation of organizational and technical measures for T = 5 is shown in Figure 4.

Production development strategies, providing for organizational and technical measures, take into account the possibility of increasing production capacity through the construction of special facilities and transitional construction facilities (completion of the previously started).

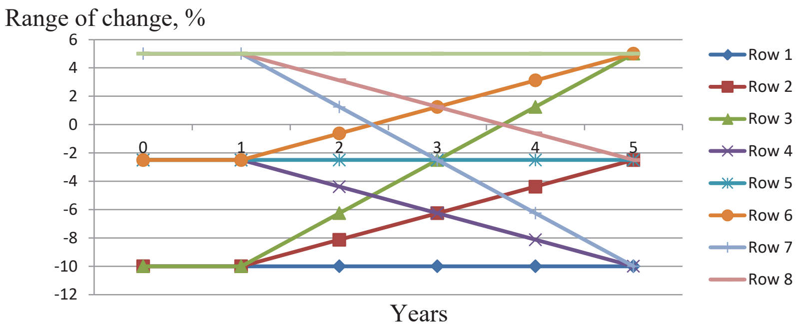


Figure 3 – Methods for changing the rate of growth of labor productivity

Let's introduce the designations: *l* – index of the capital construction object, L_i – the number of objects of the i-th type (*l* = 1,..., L_i); *j* – index of a product, position of an order or other contract of an enterprise (*j* = 1,..., *n*); *k* – index of a type of metal-cutting equipment (*k* = 1,..., *K*); *r* – index of the type of assembly areas (*r* = 1,..., *R*).

Modeling the development of production, we will characterize capital construction objects by a set of the following indexes: design capacity M_l; the year and quarter of incorporate in activ τ_l and ν_l accordingly; the standard term for the development of the design capacity γ_l; the volume of investments by years of construction w_l^t; the cost of the input industrial and production fixed assets c_l with a total area b_l; the amount of equipment of the *k*-th type λ_{lk} or assembly areas of the *r*-type η_{lr}.

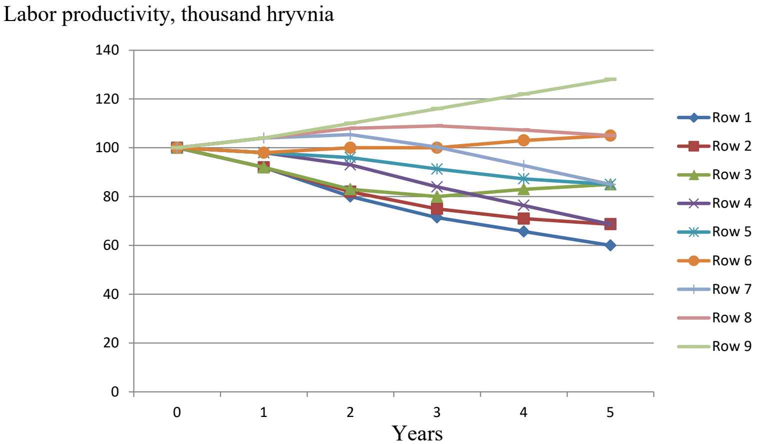


Figure 4 – Labor productivity dynamics under various production development strategies

Then the volume of production at the existing production facilities at a given rate of growth of labor productivity and taking into account the additional volume of output from the newly commissioned facilities can be determined by the formula:

$$V_l^t = \frac{P^t}{1-U^t}\left(H^0 + \sum_{a=1}^{t} \Delta H^a\right) + \sum_{t}\sum_{l=1}^{L_t} M_l \cdot d_l^d, \quad t = 1,\ldots,5, \qquad (6)$$

where H^t is the required number of industrial and production personnel in the year t (H^0 is the actual number in the base year); ΔH^t is the planned change in the number of industrial and production personnel in the year t; U^t – the proportion of purchased components and semi-finished products in the year t; P^t –labor productivity in year t, calculated in terms of value added; d_l^t –the level of development of the design capacity of the *l*-th capital construction object in the year t, determined as follows:

$$d_l^t = \begin{cases} 0, \ if \quad t < \tau_1, \\ f(\gamma_1, \nu_1, t-\tau_1), \ if \ \tau_1 \le t \le \tau_1 + 2, \\ 100, \ if \ t > \tau_1 + 2. \end{cases} \qquad (7)$$

Here $f(\gamma_1, \nu_1, t-\tau_1)$ is the standard for the volume of production as a percentage of the annual design capacity of the capital construction object, specified by Table 5.

Table 5 – The standard of the volume of production in % of the annual design capacity

Object entry quarter	Standard development period, months	Production volume,%		
		in the year of commissioning	by years of development	
			1	2
1	3	71	100	100
1	6	68	100	100
1	9	60	100	100
1	12	51	99	100
1	15	48	97	100
1	18	45	93	100
1	24	42	82	100
2	3	46	100	100
2	6	43	100	100
2	9	36	99	100
2	12	30	95	100
2	15	29	91	100
2	18	28	86	100
2	24	26	75	98
3	3	21	100	100
3	6	19	99	100
3	9	16	94	100
3	12	13	87	100
3	15	13	82	100
3	18	13	76	100
3	24	12	67	95
4	3	0	96	100
4	6	0	93	100
4	9	0	85	100
4	12	0	75	100
4	15	0	70	100
4	18	0	66	100
4	24	0	60	90

The participation of certain capital construction objects in the formation under various production development strategies is reflected in Table 6. For production development strategies that provide for the implementation of organizational and technical measures for technical re-equipment, additional output due to capital construction is calculated for objects of the type i = 1, 2.

Table 6 – Classification of capital construction objects

Enterprise development strategies	**Object types**			
	rolling construction objects	**special purpose objects (special objects)**	**other objects**	**production modules**
	(*i*=1)	**(*i*=2)**	**(*i*=3)**	**(*i*=4)**
Organizational and technical measures to maintain production capacities and technical re-equipment of varying intensity	+	+	-	+
Expansion of production of the enterprise through the construction or reconstruction of facilities	+	+	+	+
Development of production of the enterprise, ensuring the full implementation of the order and contractual obligations for the production of products	+	+	-	+

Note. The "+" sign marks the groups of capital construction objects used in imitation models that implement the corresponding production development strategy.

Determining in this way the volume of production for the next five years, it is necessary to take into account that it should not exceed the maximum possible volume of production V_2^t, calculated through the standard (maximum) removal of products from 1 sq. M. total area s^t:

$$V_2^t = B^t \cdot s^t, \quad t = 1, \ldots, 10, \tag{8}$$

where B^t – total production area at the end of the year *t*.

Then the volume of production V^t can be determined as follows (Figure 5):

$$V^t \le min\{V_1^t, V_2^t\}, \qquad t = 1, \ldots, 5. \tag{9}$$

The volume of production in the next five years can be determined by the formula:

$$V^t = V^5 \cdot \left(\frac{100 + y^t}{100}\right)^{t-5}, \qquad t = 6, \ldots, 10, \tag{10}$$

where y^t – production growth rate forecast.

If $V^t > V_2^t$ for any t = 6, ... 10, then an attempt must be made to compensate for the missing capacity by hypothetical commissioning of the capacity of the production module. To do this, by enumeration, the values and timing of the start of the construction of the module majorizing the missing capacity (taking into account the norms of its development) are determined. If none of the available modules solves this problem, then the option for the development of production at a given growth rate of labor productivity and production volumes for t = 6, ... 10 cannot be formed.

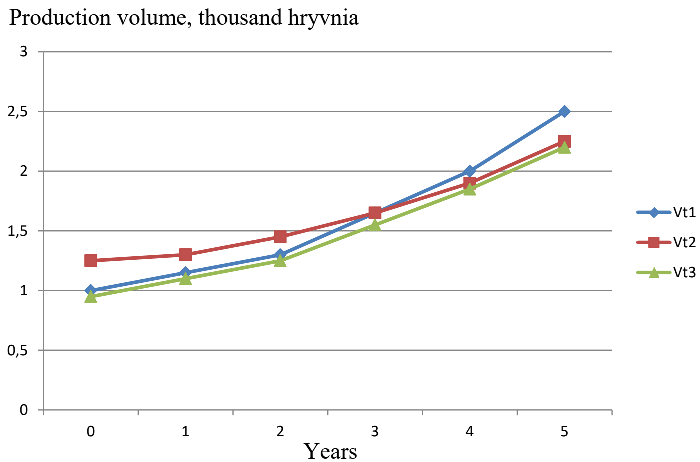


Figure 5 – Determination of the volume of production

Capital investment:

$$W^t = W_1^t + W_2^t + W_3^t, t = 1, \ldots, 10, \quad (11)$$

where: W_1^t – the volume of capital investments for maintaining existing capacities in the *t*-th year;

$W_2^t = \Delta V^t \cdot s$ – the volume of capital investments for the increase in capacity due to technical re-equipment in the *t*-th year;

$W_3^t = \sum_l w_l^t$ – the volume of capital investments for the reconstruction and construction of production facilities in the *t*-th year;

ΔV^t – increase in production volume due to organizational and technical measures for technical re-equipment in the *t*-th year;

s – the standard of specific capital investments per 1 thousand hryvnia, an increase in the volume of marketable (gross) production due to technical re-equipment.

The variety of sources of investment in production puts forward the requirement for differentiation of investment objects on this basis.

As a rule, each contract of the enterprise has one source of investment, although mixed financing is also possible, which must be reflected in the initial information, Then the calculation of W_1^t, W_2^t, W_3^t can be carried out differentially for each source of investment (own funds, state budget and off-budget investments on a non-repayable and repayable basis, bank loans, etc.)

Modeling of production development with other strategies is based on identifying the dependence of production development indicators on the main design data of capital construction objects: the purpose and design capacity of the facility, its total area, the added number of industrial and production personnel, the cost of industrial and production fixed assets, the standard term for the development of design capacity, year and quarter of putting the facility into operation, planned volumes of capital investments and construction and installation works by years of construction.

An increase in production capacity due to new construction and reconstruction of existing production is carried out on the condition that planning goals cannot be achieved when carrying out organizational and technical measures of maximum intensity, that is, $\rho^t = \rho_{max}$, or when removing products from 1 sq.m. the total area of the enterprise with the planned output volumes exceeding the standard.

Then $P^t = P^{t-1} \cdot \rho_{max}$ and

$$V^t = \frac{P^{t-1} \cdot \rho_{max}}{1-U^t} \cdot \left(H^0 + \sum_{a=1}^{t} \Delta H^a \right) + \sum_{t} \sum_{l=1}^{L_t} M_l \cdot d_l^d, \quad t = 1, \ldots, 5. \qquad (12)$$

The summation over *i* in the formulas for calculating the indicators of the variant is carried out in accordance with the classification of objects in Table 6.

For a development option aimed at full execution of contracts, the calculation of the volume of production is carried out according to the formula:

$$V^t = \frac{1}{1-D^t} \sum_{j=1}^{n} C_j \cdot Z_j^t, \quad t = 1, \ldots, 5, \qquad (13)$$

where D^t is the specific weight of the change in the balance of work in progress in the year *t*.

The governing parameters in the formation of development options due to new construction and reconstruction of existing production are the terms of commissioning of facilities or their production capacity, or both. So, in the formation of options for the construction of facilities, the purpose of the facilities, their design capacity, and the amount of required capital investments are known. Control parameters are the terms for entering objects that change in the range specified by the manager.

When forming options providing for the construction of individual production modules with a lack of capacity for the implementation of applications and orders for products, both the amount of missing capacity and the equivalent module are determined, as well as the timing of its commissioning, taking into account the norms for the development of design capacities. In this case, the control parameters are the production capacity of the module and the timing of its commissioning. The choice of the size of the module is determined from the condition of minimizing capital investments to satisfy orders for products.

The considered scheme for modeling production development strategies meets the requirements of the program-targeted approach both to planning the final output of products (implementation of contracts) and to planning investments in fixed assets of an enterprise, their specificity and targeting.

The proposed imitation models for the functioning of production facilities make it possible to form alternative options for the development of technologies for these production facilities.

Finishing the study of the model stand-generator of predictive development strategies of IIM for the purpose of assessing their possible states, let us pay attention to a very significant problem in the activities of an enterprise associated with its institutional status and economic independence in market and transitional conditions. The essence of this problem lies in the extent to which government bodies should directly influence the processes of development and distribution of production capacities of a state-owned enterprise. A. Kredisov emphasizes the integration of corporate social responsibility into the system of strategic management of a business company, which today in countries with market economies has become a defining organizational vector of business development [15, p. 29].

The theoretical study of this problem allowed us to conclude that overcoming the shortcomings of the cost-based approach to planning is associated not with individual improvements and improvements in the methods of planning calculations or planning indicators, but with a fundamental change in the entire concept of the plan, caused by the rejection of direct impacts on the processes of resource allocation of capacities of enterprises, that should become their internal affair. The influence of the planning authorities should be aimed at regulating the balances of the final results of their activities.

In this aspect, the question of detailing the very structure of enterprise models should be resolved in a compromise: on the one hand, since the development of an enterprise is its internal affair, then there is no need for a state governing body to determine its production capabilities at the level of machine tools and production areas by their types and evaluate at such a micro level the degree of realizability of demand and orders, and on the other hand, the enlarged units of the stand should not only reasonably assess the feasibility, but also form strategies for the hypothetical development of the enterprise in order to meet the demand in certain conditions of financing and solving the problems of the state in a particular area.

Thus, the question of the degree of detailing of the model stand is not only a scientific problem, but also the art of the creators of models, without crossing the brink of their oversimplification, behind which the realities of the process of forming a strategy disappear, at the same time not allowing oneself to “drown” in numerous details of overcomplication models for which you may not get an informed decision at all.

The information support of the models and the models themselves should be built taking into account the strict requirements of planning and management practice for the information support of forecasting, which in fact should allow the formation of complete life cycles of products at various degrees of detail and aggregation of initial information. To do this, it is necessary to use a full set of standards for cost, duration, intensity of work, descriptions of analogue products, etc. in varying degrees of detailing, which involves the use of both the full volume of the specified information and the minimum, aggregated amount of information, when the predicted trajectories of product creation indicators are formed on the basis of statistically substantiated parameters and characteristics of the distribution of costs in certain areas of technology and its individual performers, adequately described specially built or selected by the manager functions or analog products.

In addition to imitation models of IIM functioning, another important element of the forecasting system for technological renewal should be econometric models of full life cycles of complex technical complexes that play a major role in the generators of possible options for the implementation of these life cycles or the functioning and development of industries. They are basic, first of all, because only on their basis it is possible to harmonize industry-wide economic decisions and, in particular, intra-industry proportions, based on the objective capabilities of science-intensive experimental and production bases of industry, design and technological features of products, resource support, endogenous and exogenous factors of development and economic conditions.

D. Forecasting indicators of the potential of innovative-investment manufacture based on modeling the life cycle of products

In the main part of IIM, specializing in the production of complex single and small-scale products with a high cost of costs and a long-life cycle, including research and development (ship-, aircraft-, rocket-, turbine engineering, etc.) to predict resource consumption and compare with potential the capabilities of these industries in the near and separate perspective (forecast period), you can use econometric models of full life cycles of complex types of products – technical complexes (TC).

The full life cycle includes the whole range of works and activities for the development, manufacture and operation of the vehicle with an indication of their sequence, required resources, terms, performers and customers.

For a formalized description of the process of development, manufacture and operation of complex science-intensive products, the concept of the R&D topic is used. The R&D topic is characterized by its structure (organizational, technical, informational), the complex of works performed and their cost, terms, the totality of performers and customers, the coefficient of relative importance. The complex of works on the topic covers all its structural elements and, in the general case, is the topology of the TC structure, which is presented as a multi-level: technical complex, part of the complex, system, work.

The process of performing a theme or developing a technical complex can be divided into separate stages and typical work.

The stage reflects the level of design and development of the complex or the degree of experimental development of structural elements in accordance with the hierarchical structure of the TC. The stages of the technical complex consist of standard works, each of which is a type of production activity of enterprises in the technological process of developing the complex.

The works may include: development of documentation, preparation of production, preparation of a test base, production of models, fabrication of material parts, production of prototypes, testing, provision of tests, etc.

The comprehensive development of IIM presupposes, along with the creation and release of products, the primary targeted renewal and expansion of the production and experimental base, and the development of infrastructure. There is a need to reflect the life cycle TC and these areas. The process of capital construction of industrial and social facilities for the purposes of production development can also be structured and formalized according to a thematic principle.

The description of the structure of the topic, its formalization should be rather conventional, flexible and have the property of adapting to the depth of possible detailing of the forecast and, accordingly, to the degree of aggregation of the initial information. In practice, when planning, for example, for a 10-, 15-year period, it is difficult, and sometimes there is no need to detail the topic down to the lower level – the works listed above. Then the stages of the life cycle, which will be the specific works and activities of the topic, act as the lower level of detail.

Thematic planning is relevant specifically for science-intensive mechanical engineering, the specificity of which is manifested, first of all, in the large share of R&D. To assess the implementation of the topic, it is necessary as a technological tool to have a certain set of models for its implementation by changing the control parameters, which, together with information, algorithmic and software for a personal computer, a generator of options for implementing the topic.

E. Life cycle modeling conceptual framework

By the life cycle of a theme, we mean a full range of works and activities ordered in time by the enterprises executing the theme at all stages of its implementation. The topic can include both all stages of the life cycle (from setting the task and carrying out the necessary R&D to the full implementation of the intended goals, including the stage of decommissioning the technical complex), and one separate stage (or several stages), since not for every topic, it is necessary to complete the entire cycle "research-production". Such goals can be: development, creation and operation of a technical complex; design and manufacture of various types of products; construction, reconstruction and technical re-equipment at enterprises of production facilities and objects of scientific, experimental and social infrastructure, etc.

Work as an element of the theme's life cycle is adequately characterized by the following indexes: type (it is necessary to highlight it especially if the performer is limited in the ability to perform the total volume of this type of work); volume in value and real terms; terms and duration of implementation; resources (financial, investment, labor, material) required to carry out the work; executor; customer (funding organization).

The manager can define the sequence and timing of certain types of work as controlled events. Specifically controlled events are defined as certain beginnings and / or ends of some activities of the full life cycle of a topic. For controlled events, both the time intervals within which these events should occur and restrictions on the duration of some work can be specified.

The enterprises-executors of the work form the totality of the performers of the theme. The customer of the work, theme, program event can be a funding organization.

Lead executors receive funds for the implementation of the topic directly from its customer, state budget and other sources of funding, can use their own funds. Note that the creation of capital construction projects fits into the above scheme.

Capital construction objects can be attributed to one of two types: 1) special purpose-built objects, without the creation of which the theme cannot be implemented; 2) included in this topic as its independent element and hereinafter referred to as special purpose objects, the need for the construction of which is revealed as a result of balancing calculations and feasibility studies for the sum of topics at each of the executing enterprises and intended to increase the production capacities of these enterprises and their infrastructure.

The priority (coefficient of relative importance) of a topic is a certain number from the agreed range of change, usually from 1 to 10 or up to 100, which allows you to compare the entire set of topics, rank them and give preference to one or another of them in the allocation of resources (subject to their shortage).

Using an expert method, it is possible to select all topics and divide them into three conditional groups: a) topics that have absolute priority, that is, those for which resources are unconditionally allocated; b) topics that are provided with resources on a leftover basis; c) topics to which resources are allocated in the event that the latter are sufficient for topics of group “a”, which, however, have a preference in comparison with topics of group “b”.

As a rule, the basis for constructing admissible variants of a theme’s life cycle is the so-called initial theme’s life cycle, by varying the parameters or elements of which it is possible to form its other variants. As the initial life cycle of a theme, you can take a normative cycle, a cycle of an analogue theme, or a cycle "stitched" from separate stages and works of several normative life cycles of a theme and analogous themes.

The normative version of the cycle is formed on the basis of a system of standards, including standards for the duration, intensity and cost of the costs of performing the topic as a whole, for a separate stage or work, which can be determined calculated on the basis of empirically established dependencies, technical and technological parameters of the vehicle being developed or on the basis of statistical and design data, on the implementation of other analogous topics performed by the head organization-executing. With the help of standards, it is possible to construct a scheme of resource consumption for a normative cycle and its various variants, obtained by deforming the timing of work and, accordingly, the intensity of resource consumption.

When forming a cycle, as a rule, it is assumed that the cost of work on a specific topic is a fixed value that does not depend on the duration of the work, while changing the time of work only leads to a change in the rate of their implementation and the intensity of resource consumption.

Thus, the variation in the timing and duration of work within the specified time frame for controlled events and the cost of the topic allows us to determine the field of options for the implementation of the topic, on the basis of which it is possible to solve the problems of choosing the best options and their composition when assessing their feasibility.

F. Methods for forming the initial version of the theme life cycle

Let us consider some practical approaches to dynamic modeling of predictive trajectories of resource allocation for the implementation of full development life cycles, based on the identified statistical dependencies of the implementation of specific R&D by the head developers of various areas of technology, analog generalizations of developments, scientifically based standards of cost, duration and intensity of work.

The deterministic properties of the continuity and consistency of the development and production process of technology predetermine that the IIM development program must necessarily include topics both already in development in the current period and moving into the forecast period, as well as new ones that begin or are performed during this period and have different the degree of elaboration of their organizational and cost structure.

The structure of the rolling theme is, of course, predetermined. But in the process of analyzing the initial cycle, taking into account the actual implementation of the topic at the time of the formation of the program, it is possible, if necessary, to refine it, make adjustments to the composition and pace of work, controlled events, the amount of required resources and the intensity of their use.

The structure of a newly started topic can be defined as an expert way, in which specialists using methods for determining costs, standards, design and technological parameters of a technical complex, etc. corresponding to various areas of technology. describe and evaluate all the work on its creation, and by the method of mathematical modeling, which allows the manager to abstract from the set of insignificant factors and form the initial version of the cycle in conditions of uncertainty, taking into account the trends in the indexes of their implementation, with a minimum composition of initial information at the earliest stages of strategic planning – stages of development of aggregated indexes.

The procedure for forming the life cycle of a theme includes several stages: researching the structure of the cycle and forecasting the expected dynamics of costs for the main work; preliminary construction or selection of a predictive model (function) of resource allocation in accordance with the nature of development; determination of model parameters; assessment, including expert assessment, of the adequacy of the chosen model; direct formation of the cycle according to the selected model and subsequent differentiation of costs by stages, stages, performers.

The construction or selection of a model is carried out depending on the type of dynamics of resource consumption by similar developments, knowledge and experience of the manager. The types of resource allocation can be as follows: 1) constant growth (characterized by constant or close to it absolute growth); 2) increasing growth (characterized by increasing absolute growth); 3) diminishing growth (characterized by diminishing absolute growth); 4) growth with a qualitative change in characteristics during the program period. A similar classification can be constructed for dynamics with a systematic decrease in absolute growth.

Let's list some of the existing ways of forming the initial variants of the theme's life cycle.

1. Expert method. The initial version of the cycle is formed by expert experts. The structure of the cycle, the duration and intensity of work, the cost of costs, controlled events are determined or set by them on the basis of the technical appearance of the vehicle, methods for assessing costs on the topic, standards for the duration and intensity of work, expert assessments.

2. Linear deformation of the analogue theme. For a new TC, an analogue TC is determined, already made or under development or production, with similar functional and design-technological characteristics. The structure of the analogue theme, its cost and time parameters are known. Determine (or set) the deformation coefficient $K = W_n \ / \ W_{na}$, where W_n and W_{na} are the cost of the costs of a new theme and an analogue theme, respectively, and the life cycle of a new theme is formed.

3. Dynamic modeling of predicted resource allocation trajectories over the development life cycle. It is based on the identification of statistical dependences of the implementation of specific topics, their analogous generalizations, cost standards, duration and intensity of work.

Continuous and piecewise-continuous functions are most adequate to the dynamics of resource distribution over the cycle, since an important property of developments is the gradualness and smoothness of the dynamics of resource consumption. In planning practice, the following options are most often taken into account:

1. The dynamics of resource consumption with constant absolute growth is described by the linear function $W(t) = \alpha + \beta * t,$, t $\in$ [0, T], where α is the planned (or actual) level of costs for the topic in the initial or base year of development; β – constant annual absolute growth (β = const).

2. The dynamics of resource consumption with a change in the value and / or sign of a constant absolute increase β is described by a piecewise linear function.

3. The dynamics of resource consumption with a qualitative change in characteristics – changing trends in the dynamics of costs on the topic.

Statistical processing of annual costs for completed topics, the relationship between the amount of costs on a topic as a whole with the duration of its development and the intensity of resource consumption allow us to establish stable dependences of the cost of developing a technical complex and the nature of its distribution over time for various head developers of individual areas of technology and to determine this dependence quantitatively in in the form of a standard coefficient of cost dynamics.

4. Normative analytical method. For some types of TC, there is a stable relationship between the economic characteristics of the development of TC with its design, technical and technological parameters. In particular, statistical dependences of the duration and cost of the costs of stages and works on the TC with their intensity are established, with the overlap coefficients of the stages from these parameters.

If we denote the technical and economic indicators of the life cycle of a technical complex through $P_i\left(i=1,\ldots,m\right)$, the set of parameters through $X=\left\{x_1,\ldots,x_j,\ldots,x_n\right\}$, then $P_i=f_i\left(X\right)$, where f_i – the response function of the values of the cycle indicators to changes in the values of the parameters, and $b_j \le x_j \le B_j$; b_j and B_j – respectively, the minimum and maximum boundaries of the change in x_j.

It should be noted that the method of constructing a vehicle cycle by design, technical and technological parameters turned out to be extremely ineffective in real operating conditions of information technology: the number of control parameters set by the manager for each TC reaches several dozen, and therefore the time spent by managers to form one version of the life cycle, goes beyond the permissible limits of those time constraints that a manager has in practical planning activities.

4.5 METHODOLOGICAL FOUNDATIONS FOR CREATING A MONITORING SYSTEM FOR SECURITY-ORIENTED DEVELOPMENT

A. Monitoring objectives

The consistent build-up of SD threats due to the depressive development of IIM, due to their special significance for the economy, defense, social stability, raises the question of creating a system for monitoring the state and predicting the dynamics of these critical industry sectors with the aim of early warning of impending danger and taking the necessary protection and countermeasures.

Main objectives of monitoring:

– assessment of the state and dynamics of IIM development in a certain time period from the point of view of the criteria of economic security;

– forecasting and identifying destructive trends and processes of development of the scientific and production potential of these industries;

– determination of the reasons, sources, nature, intensity of negative impact on the potential of IIM;

– predicting the consequences of the action of threats both on the potential of IIM and on the spheres of life provided by the products and services of this potential;

– system-analytical study of the current situation, processes and trends of its development, development of targeted measures to counter IIM threats.

Monitoring primarily involves the actual tracking, analysis and forecasting of the most important groups of technical and economic indicators (indicators), including production indexes, financial, labor, etc.

B. Basic principles of organization and requirements for the monitoring system

Monitoring should be the result of interaction of all interested organizations, enterprises, departments in a specific area of IIM.

When monitoring is carried out, the principle of continuous observation of the state of the monitored object should operate, taking into account the actual state and development trends of its potential, as well as the general development of the economy, the political situation and the action of other system-wide factors.

The specificity and target orientation of monitoring determine some initial requirements for its implementation, the most important of which are: the formation and ranking of a system of safety indicators of the monitoring object, knowledge of the methods of system analysis, scientific, technological and economic forecasting of its development.

The specific features of IIM development are manifested in the need to link the ultimate goals – the production and operation of complex products – with the development of various fields of science (including fundamental), engineering and technology. That is why forecasting and strategic planning in the science-intensive sphere is largely characterized by the nature of uncertainty: the longer the planning period, the more the technical and economic indicators of production development become probabilistic. The effectiveness of planning in this case can be determined by the presence of several options for achieving the same goal and the criterion basis for selecting the best of them, which is a difficult task.

Monitoring should take into account the diversity of management influences and achievement of the intended goals, which ensures a dynamic balance of production development for the long term. Scientific and technical, investment, material resources are transformed into technological, economic and social results in different periods of time. Monitoring should be specific and targeted. The specificity and targeting of the monitoring indexes determine the adequacy, accuracy and specificity of the applied calculation and analytical tools, including for forecasting the development of production.

Science-intensive mechanical engineering has the property of inertia, which does not allow arbitrary changes in its purpose, organizational and technological structure in short periods of time. The inertia of a large technical and economic system, which is IIM, means that the current trends in the development and implementation of technical projects – trends characteristic of the past – continue to operate in the future. The greatest inertness is possessed by such parameters as the duration of development averages in the direction of technology; the present value of the development and production of products for one purpose; trajectories of changes in development costs by stages of the life cycle for a particular developer, and others. The inertia of individual indexes and planning standards gives stability to IIM development trends, maintaining cooperative contours.

The IIM process is characterized by dynamism, primarily due to the increased susceptibility to the achievements of scientific and technological progress. This requires consistency in analyzing changes in the need for new products and technologies, conducting comprehensive research on a comprehensive analysis of promising directions for the development of technology and the possibilities of their implementation in industry.

The state of IIM directly depends on exogenous factors: the state and changes in the external environment – that part of the economy and society as a whole, on which the allocation of resources for this production depends. Therefore, the development goals of a specific IIM and its resource provision should be adjusted with the main parameters of the external environment: the level of economic development of society as a whole, its need for products of the corresponding type, resource potential, socio-political climate, etc.

One of the main means of solving the problems of production development, mastering the achievements of scientific and technological progress, implementing a long-term structural policy is an investment strategy.

Forecasting IIM should be based on matching its power with the capabilities and needs of the scientific and experimental base. Forecasting and strategic planning of IIM is characterized by a rational combination of target and resource approaches, mutual coordination of program, sectoral and territorial sections, coordination of the regulatory-material and cost aspects of development and production, production and resource constraints, economic standards, and other indexes.

The monitoring technology should contain an integral part of the procedure for assessing the retrospective of production development, collection and preparation of initial information. At the same time, it is necessary to analyze the implementation of the decisions made, the current state of research and development, as well as production; it is necessary to analyze the coordination of technical proposals for the development of new systems, consideration of orders for new R&D; research of demand for applications for products; preparation of the regulatory and reference base.

For high-quality and timely implementation of the listed works, increasing the scientific validity and effectiveness of monitoring, it is necessary to develop and maintain in working order the appropriate methodological, methodological, organizational, informational and technical support.

When developing methods and tools for monitoring, it is necessary to take into account:

– the methodology and technology of forecasting and planning research, development and production adopted in a specific industry based on complete life cycles of creating complex products;

– the complexity and balance of the development of production, improvement of the experimental base and capital construction;

– balance of natural and cost indicators of production, etc.

The content and sequence of monitoring are presented in Table 7.

Table 7 – Monitoring of security-oriented development work

Stage	Content of the monitoring stage
1	Identification of a business entity – an object of monitoring
2	Formation of systemic technical and economic indexes for assessing the SD of an economic entity, taking into account the specifics of its functioning
3	Collection and preparation of information characterizing the state of the monitoring object
4	Identification (definition) of factors characterizing the promising directions of development of an economic entity
5	Modeling and formation of scenarios or strategies for the development of an economic entity
6	Calculation of technical and economic indexes of an economic entity for the entire depth of the forecast period
7	Analysis of SD indicators of a business entity
8	Development of proposals for the prevention and neutralization of SD threats of a business entity

Forecasting the development of IIM requires support with appropriate methods and approaches. In practice, such traditional methods are used as extrapolation, balance, normative, analytical, program-target; besides these, when planning R&D, methods of modeling and network planning are used. The listed methods are used, as a rule, simultaneously. The most effective in planning practice is a combination of analytical, balance and regulatory methods, as well as a program-target approach with methods of economic, mathematical and information modeling.

5. NEW APPROACHES TO STRENGTHENING THE ROLE OF INNOVATIVE-INVESTMENT MANUFACTURES IN SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

5.1 IMPROVING THE MECHANISM FOR MANAGING SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

The importance of the role and place of IIM in the technological renewal of the Ukrainian economy is occupied by state regulation of the priorities of scientific and industrial policy and the creation of an effective system for the dissemination of innovations.

According to modern scientific concepts [21, p. 740–742], the task of accelerating scientific and technological progress is solved by combining actions in two main areas of economic development:

1) organization of a highly efficient market;

2) the implementation of a centrally controlled structural transformation of the economy based on the creation of favorable conditions for the widespread dissemination of progressive technologies and the curtailment of obsolete industries.

The currently existing market of industrially and scientifically developed countries can be represented as a stable complex of firms, banks, government and public organizations. This complex is characterized by complex connections and relationships between its elements both on the basis of financial and industrial cooperation, and in the form of competition.

In these conditions, the problem of maintaining high efficiency of the market in the long term, associated with the need to ensure progressive technological shifts in the economy, is solved by combining market and centralized regulation of both economic activity and the creation and dissemination of innovations.

Market regulation affects the innovative-investment process in such a way that the production and economic system (which is an industry, corporation, enterprise), which makes little effort for its own development, almost inevitably finds itself in a so-called state of equilibrium at a low level, which is characterized by the fact that most of its resources in one form or another are spent on domestic consumption, payment of debts and interest on them. At the same time, part of the demand (sometimes significant) is satisfied, and this is how a certain state of equilibrium is achieved, which is quite stable in a static sense from a formal point of view, since such a state is practically risk-free.

At the same time, such a system cannot maintain its position (rating position) among other similar systems in a dynamic aspect, since among them there will always be those who pay considerable attention to their development, due to which many improve their characteristics and reach higher levels economic equilibrium.

In this competitive process, at present, an essential role is played by increasing production efficiency through the use of science-intensive and resource-saving technologies, the use of new types of advantages, for example, such as computer design, flexible automated production, computer information networks, etc.

At the same time, it should be considered an immutable fact that an attempt to get out of a state of equilibrium at a low level is associated with the need to strengthen the dynamic component in the economic activity of the system, which in turn leads to the requirement to work under conditions of uncertainty. In fact, the desire for development means that a significant share of the product produced and the receipt of income from it should be diverted to expenses, the possible results of which are of a long-term nature, and their effectiveness can be assessed not only in the future.

These costs include, first of all, the costs of maintaining and modernizing existing fixed assets, R&D in the field of creating new technologies and new types of products, as well as the acquisition of patents and licenses for the production of high technology products of external origin.

In the field of creating and developing a base for new technologies, a system of economic methods should also be envisaged to stimulate the growth of value added in the cost structure of an enterprise, which also contributes to an increase in costs of a dynamic nature.

A significant diversion of funds for investments in further development of the potential of the production system is inevitably associated with an increase in uncertainty in the implementation of decisions made, and, consequently, with an increase in the risk measure in achieving the intended results. In this regard, the question arises about the insurance of investment dynamic decisions and the ways of its implementation.

In our opinion, to solve such problems, one should proceed from the fact that any dynamically developing production system is a system with feedback. In technical terms, this means that in such a system, in addition to the executive core (the production process itself) and the control device in the direct control circuit, there is a feedback mechanism. The main purpose of such a control device is, based on the measurement of the results obtained and their comparison with the planned ones, to develop certain recommendations and proposals for the main control device.

In the field of economic applications, the information obtained in this way refers, in most cases, to changes in strategic and tactical decisions in the area of spending on direct investments in assets, on financing measures to stimulate scientific and technological progress, in particular on the development and development of new technologies, new types of products and conducting resource-saving measures. In addition, the feedback device allows you to receive constant information about the effectiveness of decisions made and an assessment of possible options for changing them.

The most common way of obtaining information in the feedback loop is a tight control scheme, in which recommendations for changing decisions are directly related to the deviation of the actual results from the planned ones using fixed coefficients.

The use of control loops with fixed parameters turns out to be quite effective if the state of the external environment, as well as the state of the object itself, remain stable or relatively little and predictably change, that is, the situation is sufficiently definite. However, when, due to the influence of external or internal circumstances, the characteristics of the environment or the object itself become insufficiently accurately predictable, then a situation of uncertainty arises. Such a situation may arise when the supply of goods in the markets of suppliers or the demand for products of a given production system changes greatly under the interaction of competitors or due to force majeure reasons such as changes in world prices, tightening or weakening of export or import regulations, etc.

In these conditions, strategic planning for the stable and effective functioning of an economic entity of a corporate or corporate level implies ensuring the solution of a whole range of interrelated management tasks, the main of which are:

- marketing research of the market;
- investment support of production and reproduction due to the rational organization of cash flows and borrowings;
- innovative improvement of the scientific, experimental and production base, aimed at their technical re-equipment, at the creation and use of scientific and technical, technological, design and investment (capital construction) backlogs to ensure the competitive superiority of their own products;
- improving the structure and composition of human resources, etc.

5.2 COOPERATION AS A FACTOR IN THE SURVIVAL AND DEVELOPMENT OF INNOVATIVE-INVESTMENT INDUSTRIES IN MODERN CONDITIONS

From the whole variety of ways of survival and anti-crisis development of knowledge-intensive industries, one should single out cooperation in its broad sense – research and production, financial information institutional (that is, cooperation of forms of ownership).

Part of the main reasons for the crisis in the Ukrainian economy in general and in the science-intensive industry in particular lies in the rupture or disruption of cooperative ties, in weak integration into the world economy. Cooperation of national enterprises as an effective form of their interaction and structural transformation allows saving resources – natural, labor, production, financial, etc., increasing the scientific and technological level of products and their competitiveness, implementing innovative cooperation for the purpose of scientific and technological development. In addition, international cooperation of domestic enterprises with foreign partners contributes to penetration into the domestic markets of these countries and international markets. The cooperative basis of the scientific and technological development of IIM is studied in detail, for example, in [13, p. 189–191]. Therefore, we will focus on discussing the possibilities of cooperation of various forms of ownership.

An interesting way of adaptation in the modern conditions of a transitional economy is the dissolution and interweaving of the public and the private, as well as the erosion of the boundaries of property through the formation of a network of cross (recombined) property [3]. In this regard, it is useful to study the phenomenon of a transition economy not with the help of such categories as "market", "state", "enterprise (firm)", but by analyzing the networks that are taking shape in society. From this point of view, the ability of the economy to adapt flexibly to changes in world markets is based on the cross-links of corporate groups and on the corresponding organizational forms. The study of such new organizational forms allows us to conclude that it is necessary to distinguish between market coordination and market orientation. A large number of organizational forms that are not characterized by market coordination, that is, they do not have internal market-type interconnections, can have a highly effective market orientation. Cross-ownership in this case can also be interpreted as a way of distributing risk, smoothing out differences between firms.

Here it is important to have an answer to the question: are the networks of enterprises in Ukraine oriented towards the world market and how successful such an orientation can be. This success can be measured by their contribution to the transition from a planned to a market economy. In particular, it is generally believed that the mechanism of transition can be the bankruptcy of weak enterprises. However, tight budget constraints not only lead to bankruptcy of weak enterprises, but can also destroy enterprises that could achieve high results with some support. Therefore, cross-ownership can save some of the potentially efficient enterprises by distributing them over the network. Thus, by sacrificing the efficiency of resource allocation, it is possible to preserve the assets of enterprises that have real potential to successfully operate in a transitional environment.

In addition, risk sharing can create the conditions for risk acceptance. A very high degree of uncertainty in a transitional economy leads to a reduction in investment, and their strategic goals are distorted (an enterprise invests, expecting that in a sluggish economy other enterprises will not invest). By increasing incentives to invest by reducing risk, risk sharing will help get out of a low equilibrium situation. Enterprise networks operate to disrupt low-level equilibrium and stimulate entrepreneurial risk.

Economic development requires an increase in the number of exits and entrances to the market, which should be accompanied not only by the creation of new organizations, but also by the passage of new organizational forms. Organizational forms are a collection (collection) of different options for activities, and reducing their diversity means the loss of information that can be used for organizational change. From this point of view, an economy that maximizes “resource allocation efficiency” by transferring all resources to the most efficient form loses in achieving adaptive efficiency.

Useful endeavors can fail, not only because there is no mechanism for the selection and elimination of weak production units in a transition economy, but also because economic resources are used only in a small number of organizational forms. The emergence of cross ownership should be assessed not in terms of the reproduction of old forms or the development of private property, but in terms of the contribution to the growth of adaptive efficiency.

Blurring enterprise boundaries is a viable strategy for increasing organizational flexibility in developed countries in the face of rapidly changing market conditions or accelerating scientific and technological progress.

As a result of property erosion, an alternative to the usual buy-sell relationship arises, namely cooperation. At the same time, an insurance (hedging) strategy appears, which is associated with cross-ownership of enterprises. With such a complex interdependence of assets, the fuzzy definition of property rights, namely their vagueness, ambiguity, allow flexible adaptation to market changes. Economic agents do not share the rights to assets, their rights overlap, which increases the stability of the system as a whole.

In conclusion, it is necessary to point out the need to develop methods of economic assessment of the effectiveness of the formation of special mechanisms for adapting production to changing conditions. At the same time, it is necessary to present the rules according to which the positive effect obtained from the exact implementation of the planned strategies should be compared with the costs associated with the implementation of special adaptation measures, on the one hand, and with the involvement of additional material and financial resources, on the other. Apparently, the solution of such a problem in general form is very difficult, however, in finding satisfactory results for specific problems, one can hope for success.

CONCLUSION

Innovative-investment manufacture are becoming the most important characteristic of a strong state. Today they serve as an indicator of the strategic level of economic power of the country, its national status. Adaptation of science and industry to the conditions of market economy requires purposeful state support. It depends on whether Ukraine will be a raw material appendage of modern economies in the future or will have one itself.

Despite the unfavorable combination of circumstances for the science-intensive sector of Ukrainian industry, its preserved capabilities are the most promising basis for scientific and technological independence of Ukraine, its security-oriented development. Using these opportunities as a source of economic growth is the last and, perhaps, the only chance for Ukraine to build a modern economy, to maintain its status in a number of economically developed countries.

The shortest way to achieve this goal is through an effective scientific and industrial policy, the basic preconditions for which have not yet been completely lost. These include the following:

a) the presence in the country of a strong intellectual potential, which is based on the formed system of education and traditionally high level of scientific and technical culture;

b) the presence of high-tech industries that have research and production potential that can be the result of the necessary structural changes, the driving force of economic growth;

c) existing and world experience in creating a system for the dissemination of technological advances in production with a lower technical level;

d) the initial conditions (including legislative ones) are gradually and steadily formed, which contribute to the structural reform and development of corporate strategies of domestic producers in the struggle to increase their competitive opportunities in domestic and foreign markets.

Scientific and industrial policy should be based on the principles of systematization, coordination, priority of R&D and selectivity (target orientation) of measures of state support of knowledge-intensive industries, supported by the primacy of domestic producers in the domestic market and protectionist actions of Ukraine towards EU integration.

Development and implementation of scientific and industrial policy aimed at revealing the potential of the real sector of the economy, will reverse the crisis trends in socio-economic development of the country, begin to reduce the existing composition and forms of threat to its security-oriented development.

Measures to prevent and prevent threats to security-oriented development in various, including knowledge-intensive industries should not be situational in nature, but based on long-term analysis of trends, processes and possible development strategies of economic entities in specific conditions. Timely market economy in many aspects of innovative-investment activities makes strict requirements – from working with information to personal behavior. And in these cases, methods of competitive intelligence may not be superfluous.

The basis for such an analysis in relation to the field of R&D and innovative-investment manufacture is economic and mathematical tools for the formation of development strategies of economic entities and assessment of the dynamics of their security-oriented development during the forecast period or at the end of this period.

To improve the quality and efficiency of analysis and evaluation of security-oriented development of innovative-investment production, a system of continuous monitoring is needed, which allows not only to identify the nature and degree of threats but also to anticipate and take timely measures to prevent them.

The specificity and purpose of monitoring determine some initial requirements for its implementation, the most important of which are: the formation and ranking of the system of safety indicators of the monitored object, justification and establishment of their threshold values.

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